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THE PROBOSCIS OF THE HOUSE-FLY.

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THE common house-fly of Europe (*Musca domestica* L.) probably includes the American as well as the old-world forms.[1] Its proboscis has attracted much attention and been the subject of

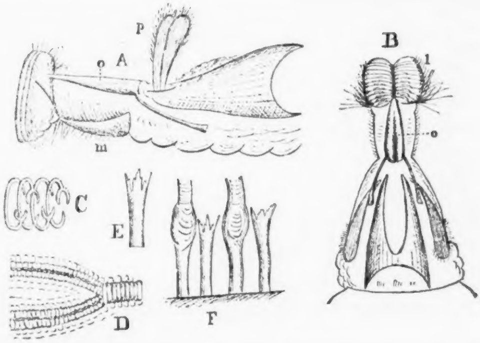

FIG. 1, *A–F*.—*A*, right side view; *B*, dorsal view of proboscis of *Musca domestica*; *C*, semi-tubes of its false tracheæ; *D*, two of the false tracheæ with wrinkled membrane between; *E*, a tooth; *F*, arrangement of teeth between roots of false tracheæ. In *A* and *B*, *l* represents the tip; *o*, the operculum; *p*, the palps; *f*, the fulcrum; *m*, the mentum.

much misapprehension. I have recently been fortunate enough to find out several important points about the mechanism of this organ and the homologies of its parts.

[1] Harris had cast a doubt on this and given the American forms the title *M. harpyia*, in remembrance of his disgust at "these filthy dungbred creatures." Prof. A. S. Packard, Jr., has established their claim to a place in the Linnæan species, *M. domestica*.

Its Structure.—The proboscis consists of three divisions—base, mid segment and tip. The base, or proximal division, contains:

1. A large framework of hard dark-colored chitin (*f* in Fig. 1, *A* and *B*, represented in the margin as spread out). This has been termed the *pharynx*, or *fulcrum*, by Lowne.[1] In the natural position this fulcrum is a narrow box, open at both ends, and sending processes backwards and forwards. The distal part of its roof is left open so as to receive the mid segment in flexion. One of Lowne's terms for it (*pharynx*) is incorrect; it is rather a case surrounding the pharynx. I shall refer to it by the name *fulcrum*.

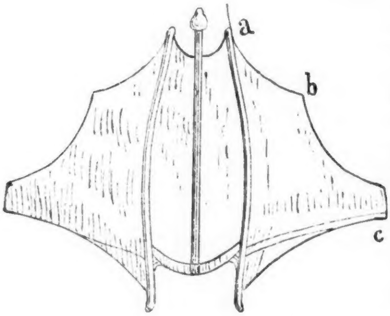

FIG. 2.—The *fulcrum* spread out, showing its lower (ventral) plate with curved margins, its distal (*a*) and subdistal (*b*) processes, its wings (*c*) which arch over its chamber and meet above, and its proximal processes (*d*). It terminates distally in a small nodule.

2. Two palps (*p* in Fig. 1, *A* and B) not jointed, but borne on a weak cross-piece of chitin. (The blow-fly has stronger supporting bars, and palps longer and more slender.)

3. A transparent funnel-shaped sheath widening towards the head, surrounds the basal division. This membrane consists of chitin, but is quite soft and movable, like the membrane of the tracheæ or the web of the wings of insects. It is directly continuous with the walls of the head, and it extends forward to enclose the whole proboscis and to form the walls of the lips. It is open above so as to allow free motion to some of the hard parts.

The mid segment folds on the basal segment by an elbow joint. On the under side of the mid segment is the *mentum*, or chin piece (*m* in Fig. 1 *A*), truncated behind, narrowing and bifurcated in front, not articulated to any hard supporting part, but fixed in the membraneous sheath which holds it in its place.

Uppermost in the mid segment is the *operculum* of Lowne (*o* in Fig. 1 *A*, *B* and Fig. 3). This is a semi-tube, slit beneath, pointed in front, and sending backwards two long processes which I shall call "the great tendons."

[1] "The Anatomy and Physiology of the Blow-fly," by B. T. Lowne, Lond. 1870.

In the central axis of the mid segment, and closely articulated to the front processes of the fulcrum, is a plate (Fig. 3, *x*) longitudinally curved upwards so as to embrace the operculum, and with it to form a canal. Its central axis and its lateral parts are thickened. Lowne calls it the cannula. It may be convenient to refer to its lateral arcuate thickenings as the *trabeculoid arches.*

Lying in the channel formed by the operculum and cannula, and firmly articulated behind with the front end of the fulcrum, is the lingua, or hypopharynx (Fig. 3, *l*). This is rather short in the house-fly, but is long in Stomoxys, serving as a piercing organ.

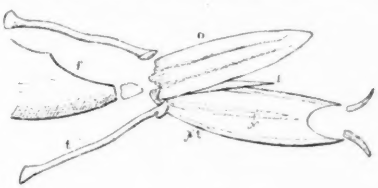

FIG. 3.—Arrangement of hard parts of mid segment (mentum not here shown). *o*, operculum, sending back the great tendons, *t*; *x*, the axis piece or cannula; *xt*, trabeculoid arches; *l*, lingua, or hypopharynx; *f*, the fulcrum (part of it). In front of the trabeculoid arches are seen the beginnings of the circum-oral rods.

The opercular piece and the hypopharynx habitually lie on the axis piece, whose edges overlap it, but they may be started up so as to project clear above the sheathing membrane of the mid segment without any rupture of the membrane.

The distal segment, or tip, called "knob" in Burmeister's Entomology (Fig. 1, *A* and *B*, *l*), is a singular scraping and suctorial apparatus, with the oral opening in its upper part set amidst the large protrusible lips. When spread out its surface is covered by a system of about eighteen pairs of curved transverse ridges. These have a general resemblance to tracheæ. Suffolk[1] calls them pseudo-tracheæ, that is, false tracheæ. They are split tubes, having a rent along their anterior surface, and are supported by a framework of chitinous semi-tubes, which are forked at alternate ends (Fig. 1, *D*, shows the relation of two of these false tracheæ with the intervening membranous crenulations). The line of opening of these tubes is zigzag, caused by the sheath-membrane flapping over the forked terminations of their supporting semi-tubes.[2] This line of opening can be shut so as to produce a closed channel, or opened and made rough like the face of a file.

[1] "On the Proboscis of the Blow-fly," by W. T. Suffolk, in Monthly Microscopical Journal, June, 1869.

[2] Well described and figured by G. Hurst in Quarterly Journal of Microscopical Science, 1856, p. 238. Fig. 1, D.

On both sides of the mouth are hard beams of chitin, supported on the trabeculoid processes of the axis piece of the mid segment (Fig. 3, *xt*), and themselves affording a foundation for the false tracheæ. We shall call them the circum-oral rods (Fig. 1, *F*). On the circum-oral rods, and intervening between the roots of the false tracheæ, is formed a set of teeth. The blow-fly has three rows of these teeth (thirty teeth in all), each tooth being two-cusped. A small house-fly (similar to *M. domestica*) has a similar arrangement, as has *Musca cæsar*. The carnivorous house-fly has only one row of five or six teeth on each side of the mouth, but the teeth are three-cusped, the cusps being more or less cut (Fig. 1, *E* and *F*). The blow-fly has been found to use its teeth for scraping sugar-candy.

I would suggest that these distinctions in the structure, number and arrangement of the teeth are of generic value, and that the name *Musca* be applied only to those species having a single row of three-cusped teeth; whilst *Calliphora*, already made to include the blow-fly, should take in those having several rows of two-cusped teeth.

On the distal end of the mentum of the mid segment, are two elastic chitinous bands, clasping the tip from behind. When these bands are pulled apart by muscles inserted in the mentum, they open the lips wide. Muscles and tracheæ are variously distributed throughout the proboscis. At base of the tip is a nervous ganglionic mass which sends fine filaments to small terminal ganglia at the lower extremity of the lips, two of these ganglia being borne on the dichotomous branches of each nerve-pedicel. The surface of the proboscis supports hairs at various parts, especially on the palps and at the tip. The tip itself has no muscles; it is tumid but not fleshy.

The proboscis of the blow-fly and other Muscidæ corresponds, except in detail, with that of the house-fly. The proboscis of the piercing-fly (*Stomoxys calcitrans*) has not the swollen tip, and its sheath is converted into a brown annulated tube, split above. Its basal part is retractile and exactly as in the house-fly. Its opercular piece, hypopharynx and axis piece are much elongated, as a piercing rather than a merely suctorial apparatus. In many points the oral apparatus of the mosquito corresponds so closely with that of the Muscidæ, as to render valuable help towards the interpretation of the latter.

Functions.—1. The proboscis is an organ of suction. The œsophagus traverses the inferior central part of the fulcrum, thence passes through the mid segment in the canal made by the operculum and the axis piece, being here joined by a pair of salivary ducts; it then opens at the mouth, communicating with the false tracheæ. It can exude a drop of clear fluid from the salivary ducts, and when the proboscis is distended it can act as an organ of suction, receiving fluids from the false tracheæ and conveying them to the digestive organs. The large supply of muscles within the fulcrum and in the axis piece, appears to be subservient to this process.

2. Retraction. — Two long and powerful retractile muscles extend from the back part of the skull (near the foramen magnum) to the proximal end of the mentum (Fig. 1, *A*, *m*). By contracting, these draw in the mid segment, so that its proximal end is close to the neck of the fly. Other muscles attached to the ventral proximal processes of the fulcrum assist in drawing it in and up, thus turning the fulcrum upon its upper proximal processes which are hinged to the frontal piece of the skull. Thus the two proximal segments of the proboscis are folded on each other, and are both drawn inwards and upwards into the skull, so that they are like the letter V lying on its side, with its acute angle backwards. One arm of this V is hinged to the lintel of the door-way, whilst the other arm bears the collapsed tip of the proboscis, which now serves as a door to close the entrance. The ends of the palps then protrude from the upper part of the doorway on both sides of the proboscis tip.

3. Protrusion.—The part taken by inflation in extending the proboscis, is so obvious that it was suggested nearly a century ago by Gleichen, but the suggestion was rejected, and W. T. Suffolk[1] infers that the structure of the interior of the head was unknown to Gleichen, "as the extension of the organ is attributed to inflation, and not to muscular action."

It is easy to dispose of Mr. Suffolk's hasty criticism. Immerse the head of the fly in caustic potash, which destroys the muscles, the chitine of the membranous sheath and the tracheal tubes remaining intact, and you can still protrude the organ by slight pressure. Further, when the proboscis is pressed out and all its parts distended, pierce with a needle the swollen air sacs under the

[1] Op. cit.

tip, and at once the tip collapses upon the mentum.[1] If you tear the membrane about the base of the proboscis that part collapses. If you press the head over much, the membrane-sheath sends out bulging processes which soon burst, sending bubbles of air through the water in which you are examining it.

I have repeated these experiments so often as to be satisfied that the rich tracheal system which crowds the lower part of the cranial chamber is the chief agent in protruding the proboscis.[2]

The examination of the muscular arrangement justifies this conclusion. Muscles cannot directly protrude anything, they only pull. In the fly they may and do aid in protruding the proboscis by swinging out the fulcrum. The long muscles which retract the mentum aid in straightening the proboscis when it is protruded, but the mentum is not attached proximally to any hard structure, and its firmness and power of supporting the tip depends on the tense condition of the membrane in which it lies, and this. tenseness is due to inflation.

The great tendons which run back from the opercular piece (Fig. 3, *t*) have their tips united by muscles to the distal and the sub-distal processes of the fulcrum (*f*). Lowne understands these muscles to be flexors of the mid segment upon the basal segment. Their tendency on contracting would be rather as extensors; but both suppositions are wrong. When they contract, instead of flexing the mid segment, the great tendons themselves bend, for they are too weak and too slightly articulated to the operculum to stand much pulling. Their work is of a more delicate nature. By acting alternately on the tendons, these muscles bend the tip of the fly from side to side, enabling this organ to move nimbly from place to place, as you may see it when foraging on your breakfast table. This mechanism is well developed in *Stomoxys*, where only the basal part of the proboscis is protrusible. We have already seen that the muscles extending from the mentum to the divergent rods which embrace the tip, serve to expand the lips to their fullest width; at the same time the tips become tensely swollen by air.

[1] It occupies this position when the proboscis is withdrawn, but never so in the living fly when the proboscis is protruded. Most of the figures in books represent it in this unnatural state, probably drawn from dead specimens.

[2] I had made this discovery before I was aware that Gleichen had fallen upon it so long ago. The rejection of his views may explain why so little attention has been given to it by others.

Thus we find that the protrusion and distension of this important organ is a joint affair, the tracheal system and the muscles combining their services.[1]

Homologies.—It is strange that no previous observer seems to have been struck by the evidence of the "great tendons" of the operculum as to what is the organic base of the mouth parts. These tendons are found, so far as we have observed, throughout the Diptera; they are evidently the tendons of some of the mouth parts, marking their origin. They could not be in the mid joint of an appendage; the muscles which move the segments of any arthropod appendage on each other, are *internal;* it is only when we get to their root that we find these tendons extending into the body of the animal. Hence we conclude that the mid segment is the true base of the fly's proboscis. We may, perhaps, go further and hold that these great tendons belong to the mandibles, for they closely resemble the mandibular tendons of other orders of insects and of the lobster. This will make the operculum represent two united mandibles, probably enclosing the labrum.[2]

The palps seem to point out the maxillæ, but it is not easy to determine to which of the hard pieces they belong, as they are borne on slight indurations of the membrane. The axis piece, with its trabeculoid bars, seems to represent the maxillæ with its inner and outer processes. The hypopharynx and mentum offer no difficulty. The small piece represented in Fig. 3 in advance of the fulcrum, may belong to the maxillæ. The membrane sheath and tip with spreading lips may be regarded as the labium with its specially developed paraglossæ.

Having made out the chief mouth parts as represented by the

[1] Gegenbaur approaches this discovery in commenting on the tracheal system of insects in water. The branchial tracheæ are kept distended in water by inflation, and he thinks that the tracheal system has a "hydrostatic function," which, in some cases, may be more important than their respiratory function. It is probable that the tracheæ of insects serve more purposes than we have yet recognized.

See Prof. Packard's account of the hydrostatic functions of the larval tracheæ of Corydalis, which illustrates and confirms Gegenbaur's view. AMERICAN NATURALIST, Vol. VIII, p. 533.

[2] Huxley says (Anatomy of Invertebrated Animals, p. 427; in American edition, p. 369): "In the common house-fly the labrum, mandibles and maxillæ coalesce at their origins and constitute the base of the proboscis, which is mainly formed by the confluent second maxillæ. Its longitudinal grooved anterior face is overhung by the elongated styliform labrum." It is probable that the author was misled by endeavoring to condense the views of others in this part. Anything done by himself would scarcely be so faulty as this passage unquestionably is.

mid segment and the tip, we have still the largest structure of all (the fulcrum) to explain. It seems to be general in Diptera; even the mosquito possesses it; in other insects it is unknown. It could not be what Prof. Huxley suggests, "the labrum, mandibles and maxillæ coalescing;" at least its structure and forms in various Diptera give no evidence of such union, and how then are we to explain the mid segment with the great tendons? Mr. Lowne makes it a composite structure, the dorsal part being epistoma, and the ventral part pharyngeal, formed in the wall of the alimentary canal. This explanation will not satisfy, for the inner surface of the fulcrum has many muscles, which could not be there if it were only a chitinous lining of the œsophagus. One might as well expect to find muscles growing on the outside of a lobster as within its throat.

In searching after the homology of this piece, I soon found that I must go outside the Diptera, nor was I long searching till the secret came out. Opening the head of a katydid and of a wasp, I found in both what I wanted; the endocranium, which runs from back to front of skull, strengthening it. Long ago Burmeister informed us that the Diptera have no endocranium, but their skulls are as empty shells, easily fractured. But here we see that Burmeister was wrong; they have the endocranium in the proper position when the insect is being hatched and when its proboscis is withdrawn; but instead of having it rigidly fixed in the skull, they have it free posteriorly, hinged in the front and able to swing out so as to form a pedestal for the mouth parts which make up the proboscis.

Comparing Mr. Huxley's excellent description of the endocranium of the cockroach,[1] we find the relation of parts with the retracted proboscis of the house-fly to correspond exactly. The endocranium has axis and wings corresponding to the structure of the fulcrum (Fig. 3). Its posterior extremity close to the foramen magnum, and the œsophagus pierces it; so with the house-fly when the fulcrum is turned in. The great tendons of the mandibles are right and left of it, as we have seen them to be in the house-fly. What is true of the house-fly is, we believe, generally true of its order.

Thus we have fallen upon a modification of structure dependent on metamorphosis of function, almost as striking as that which

[1] Anat. Invert. An., p. 403–404 (348 of American edition).

exists between the suspensor of a bird's mandible and the small bones of the human ear.

I find in the lobster a structure which is probably homologous with the endocranium of insects. It is an opademe running like a bulk-head across in rear of the rostrum, consisting of a central cross bar, and on each side two free plate-like wings. Under its central bar is the frame work which supports the stalked eyes. Its hinder surface gives attachment to muscles which reach the stomach. It is described by Huxley (*Anatomy of the Invert.*, p. 274, of American edition) as the opademe of the ophthalmic samite.

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SKETCH OF PROGRESS IN MAMMALOGY IN THE UNITED STATES IN 1879.

BY DR. ELLIOTT COUES, U.S.A.

THE year past has seen very little progress in our knowledge of recent Mammalia, so far as contributions to that subject in the United States are concerned. Mr. J. A. Allen, one of the recognized leaders, has apparently been too busy with his great work on seals (now in press and about half printed) to do much else in mammals, and the present writer's labor in the same field has been confined to the "History of North American Mammals." The latter is still too far from completion to speak about; but Mr. Allen's *Pinnipedia* may be expected to appear very shortly, doubtless in 1880. Having the supervision of its publication in its passage through the press, the writer is in position to speak confidently of its merits and importance. It will make an octavo of perhaps 800 pages, illustrated with numerous wood engravings, mostly original; and will unquestionably become at once *the* work upon the subject. In thoroughness of treatment, accuracy and extent of investigation, and other requirements of masterly workmanship, it will compare with the author's celebrated memoir on the American bison.

As Prof. Leidy has done nothing during the year, either in fossil or living mammals, the field of the former has been left to Mr. Marsh and Mr. Cope, whose important contributions are noted beyond.

Certainly the most notable and perhaps the most significant paper on mammals of the past, present and, we may add, of the

future, is Mr. Cope's, "On the genera of Felidæ and Canidæ," in the Proceedings of the Philadelphia Academy, giving the author's views of their primitive types and of the successive steps through which they have passed, with detailed characters of the genera, including several new ones, and a nominal list of the species of both families. In the Felidæ, Mr. Cope recognizes altogether fourteen genera (including *Cryptoprocta*, between *Smilodon* and *Pseudælurus*) and ninety species—which are probably too numerous in the genera Felis and Lyncus, as the author remarks. In adopting *Uncia* of Gray as a generic term, the author assumes it to be derived from *Uncus*, a hook, but is it anything more than "ounce" in Latin? *Dinictis cyclops* n. sp., is fully described, p. 176. The interest of this paper perhaps centers about *Synagodus mansuetus* and *Dysodus pravus*, two new genera and species founded upon before-supposed varieties of *Canis familiaris*. Of the *Synagodus* it is stated to be "uncertain whether any species of this genus exists in a wild state. Should such not be the case, we can only predicate the former existence of such an one as entirely different from the *Canis familiaris*, and which has given origin to the existing one." *Dysodus pravus* is the Japanese lap dog. These are regarded as "the most specialized of the *Canidæ*." In this connection the author refers to the frequently-observed reduced dentition of man, and reasons from "what is elsewhere known in zoölogy, that the same or nearly the same specific characters may be found in different genera," that different genera may be found in the same species, which becomes a different species upon the circumstance of being referred to a new genus. Two hypothetical genera of *Hominidæ* to "be at some future day added to *Homo*," are named and described in anticipation of the establishment as a generic character of certain dental peculiarities, namely: *Metanthropos* with incisors $\frac{1}{2}$, and *Epanthropos* with molars $\frac{2}{2}$. The species of these genera, left unnamed, may be provisionally designated respectively *M. incipiens* and *E. procul*, with reference to their extremely primitive state of possible accomplishment. Much might be said, doubtless, for and against the availability of names proposed for conjectural species *in futuro*. The logical extreme of the procedure might be a potential *Pseudanthropops gingivatus*, that is, an hypothetical anthropomorphic super-simian without canines; the dental formula of which would be, according to our inference and our ignorance, I. ?, C. $\frac{0}{0}$, Pm. ?, M. ?. The new spe-

cies of *Canidæ* of this paper are *Temnocyon coryphæus* and *Icticyon crassivultus*.

In the same part of these Proceedings (April–October) Mr. H. C. Chapman describes the placentation of *Macacus cynomolgus*, and an earlier one by the same author is on the anatomy of the Chimpanzee, illustrated with four plates. Mr. John A. Ryder continues from his paper of 1878 (pp. 45–80) his notes on the mechanical Genesis of tooth forms, seeking to show the modes in which the teeth of mammals are modified by movements of the jaws in mastication, through a long series of generations; reaching the conclusion "that mechanical strains and impacts had probably been the secondary causes to which the origin of the various forms of teeth might, in a large measure, be attributed." He here offers some new evidence based upon more accurate observations of the mode in which herbivorous ungulates masticate their food. In the same line of research, Mr. Cope has a paper on the origin of the specialized teeth of the Carnivora, in the NATURALIST for March, 1879, p. 171.

Other articles on recent Mammalia by the same author in the same journal, are on the California gray whale, p. 655; on the Japanese lap dog, p. 655, and a paper on the zoölogy of Montana, p. 433. Various other brief articles or notes on mammals in the NATURALIST need not be more than alluded to here.

The Bulletin of the United States Geological Survey contains two important papers, by Mr. Allen, on the genera *Nasua* and *Bassaris*, in which the specific characters and very complicated synonymy of the two species of each genus which the author allows to stand, are carefully worked out.

For the rest, several of the newspapers of semi-scientific character give a fair space to game mammals, as they do to birds; *Forest and Stream* and the *Chicago Field* are to be specially mentioned in this connection. Among other subjects the question of hydrophobia from the bite of the skunk has occupied a prominent place; the contributions, however, being mostly the experiences of unscientific observers. It seems to be established: (1.) That skunk bite may produce a fatal disease undistinguishable from *rabies canina*, or ordinary hydrophobia; (2.) that skunk bite may be perfectly innocuous, and therefore, (3.) that hydrophobia from skunk bite only results under a rabid condition of the animal. No peculiarities of the case, as distinguished from that of a mad

dog or cat, appear to have been established, notwithstanding repeated assertions that skunk bite is always and necessarily fatal.

To the elucidation of fossil mammals the contributions of Mr. Marsh and Mr. Cope have been both numerous and important. If these still continue, as in former years, to represent the accumulation of material in the way of new genera and species, and the general enlargement of the view, rather than the attainment of final results based upon all the data acquired, they nevertheless include important discoveries and generalizations.

Foremost among these comes Mr. Marsh's discovery of Jurassic mammals in this country. The original announcement was made by Mr. Marsh in June, 1878, in the *American Journal of Science*, with description of *Dryolestes priscus* from the Atlantosauris beds of the Upper Jurassic, the associated fossils being mainly Dinosaurians.

To this succeeded, in July, 1879, the notice of *Stylacodon gracilis*, and in September, 1879, additional remains of Jurassic mammals were described as *Dryolestes vorax* and *Tinodon bellus*. It is interesting to observe, first, that the Jurassic genera indicate as many new families, and further, that they confirm Mr. Marsh's original determination of the Atlantosaurus beds as Upper Jurassic.

The same journal for June has also an interesting paper by the same on polydactyle horses, recent and extinct. It is illustrated with a plate of the genealogy of the horse, showing the modification of the limbs and teeth from *Orohippus* to *Equus*. This paper defines clearly, for the first time it is believed, the true difference between the orders none too aptly named Perissodactyla and Artiodactyla by Owen. The difference between the "odd-toed" and "even-toed" structure is stated to be "a profound one, extending to nearly every part of the skeleton, and marking two distinct groups of Ungulates. The number of toes has really nothing to do with the true distinction, and hence the terms in use are especially misleading. The real difference, so far as the feet are concerned, is, that in the Perissodactyle type the axis of the limb passes through the middle of the third digit *(Mesaxonia)*, while in Artiodactyles it is outside of this digit *(Paraxonia)*, between it and the fourth."

Mr. Cope's contributions to the same branch of the subject during 1879, will all be found in the publications of the Philadel-

phia Academy, of the American Philosophical Society, the AMERICAN NATURALIST, and the U. S. Geological Survey "Bulletin." The first of these has been already noted in connection with recent mammals. The NATURALIST contains many short papers, among which are: Extinct Mammalia of Oregon, p. 131 (in full in Bull. U. S. Geological Survey, No. 1, Feb. 28, p. 55–69); *Merycopater* and *Hoplophoneus*, p. 197; a new Anchitherium *(A. præstans)*; A Decade of Dogs (five genera, ten species) p. 530; and the Cave Bear of California *(Arctotherium simum* sp. n.), p. 791.

Mr. J. A. Ryder, in the NATURALIST for September, notes a remarkable genus of sloths, *Grypotherium* Reinhardt, typical of a sub-family *Diarhinæ* and a species of *Cælodon* Reinhardt, 1878.

Mr. Cope's paper, above mentioned, in the Hayden Bulletin, describes for the Miocene Territories of Oregon: *Enhydrocyon* (g. n.) *stenocephalus*, *E. basilatus*, *Poëbrotherium sternbergii*, *Boöchærus* (g. n.) *humerosus*, *Lutrictis lycopotamicus*, *Protolabis transmontanus*, spp. nn.

The same author's "Relations of the Horizons of Extinct Vertebrata of Europe and North America," in the same Bulletin, pp. 33–54, is doubtless his most important contribution, but it is one to which it is impossible to do justice in the present connection. His conclusions are:

"I. Portions of all the faunæ of all the primary divisions of geologic times have been recognized on both the European and North American continents.

"II. Parallels requiring general identification of principal divisions of these fauna may be detected. These are: the Coal measures; the Permian; the Laramie; the Mæstrichtian; the Eocene; the Miocene.

"III. Exact identifications of restricted divisions may be made in a few instances only; such are the Turonian and the Niobrara; the Suessonian and the Wasatch; the *Equus* beds and the Pliocene."

The Bulletin of the U. S. Geological Survey, Vol. v., No. 2, published September 6, 1819, has a paper by Mr. Cope, on the extinct *Rhinoceridæ* of North America and their allies, which goes very fully into the characters of the group, giving new definitions of Perissodactyle families and genera, and describing many of the latter in detail, with analyses of various species.

The same paper is adapted to the AMERICAN NATURALIST for December, 1879, pp. 771*a–j*, with eight cuts.

Pages 798*a–b*, of AMERICAN NATURALIST for December, give in brief some of the more important results of Mr. Cope's recent trip to the Pacific coast, describing among other things the remarkable new fossil cats, *Archælurus debilis* and *Hoplophoneus platycopis*.

Mr. Cope's Palæontological Bulletin, No. 31, being a "Second Contribution to a Knowledge of the Miocene Fauna of Oregon," "read before the American Philosophical Society, December 5, 1879," contains descriptions of the following new fossil mammals: *Hesperomys nematodon, Sciurus vortmani, Canis lemur, Chænohyus* (g. n.) *decedens, Thinohyus trichænus, Palæochærus subæquns, Coloreodon* (g. n.) *ferox, C. macrocephalus.* The date of printing is given as December 24, 1879.

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A REVIEW OF THE MODERN DOCTRINE OF EVOLUTION.[1]

BY E. D. COPE.

THE doctrine of evolution of organic types is sometimes appropriately called the doctrine of derivation, and its supporters, derivatists. This is because it teaches the derivation of species, genera and other divisions, from pre-existent ones, by a process of modification in ordinary descent by reproduction. The opposite or creativist doctrine teaches that these forms were created as we see them to-day, or nearly so; and that the natural divisions and species of organic beings have never been capable of change, the one into the other.

I. The Evidence for Evolution.

The reasons which induce me to accept the derivatist doctrine, and to reject the creational, fall under the two heads of probabilities and conclusive evidence. The probabilities are cumulative in their pointings, and form part of a total body of evidence which is, to my mind, conclusive. The reasons why derivation is probable are the successional relation of increment or decrement of structure, observed in:

[1] Abstract of a lecture delivered before the California Academy of Sciences, Oct. 27, 1879.

1. Systematic relation (taxonomy); 2. Embryonic growth (embryology); 3. In geologic time (palæontology); 4. And in the coincidence in the successions seen in Nos. 1, 2 and 3.

The fact that it is necessary to arrange animals in an order corresponding with the phases of their embryonic history is remarkable; but the further fact, shown by palæontology, that the same succession marked the ages of past time, at once brings evolution within the limits of strong probability. Nevertheless, all this might have been a mere system, without transitions between its members; organic types might have been created unchangeable, but presenting the mutual relations in question. But if transitions among these members can be shown to take place, then indeed the phenomena mentioned receive a sufficient explanation. They are seen to be the necessary relations of the parts of a shifting scene of progression and retrogression; they express combinations of structure, which, though often long enduring, are, nevertheless, not perpetual, but give way to other combinations to be in their turn dissolved. Now, if there is anything well known in nature, it is that there are divisions of various ranks in the vegetable and animal kingdoms, whose contents present variations of structure which are confessedly additions to or subtractions from the characters of ancestors, which have appeared during ordinary descent. The protean species, genera, etc., are well known to biologists, and every naturalist who admits varieties, sub-species, sub-genera, etc., admits derivation so far as they are concerned. The facts of variation, including "sporting," etc., are notorious, not only among domesticated, but also in wild animals and plants. The facts have led some persons to suggest that species have been produced by evolution from a single specific center, but that the genus and other comprehensive divisions are unchangeable. But I think I have shown, in a paper entitled, "The Origin of Genera,"[1] that the structural characters which define genera, and even higher divisions, are subjects of variation to as great an extent as are the less profound specific characters; and, moreover, that the evidence of derivation which they present is singularly clear and conclusive. The changes of both genus and species character are always of the nature of additions to or subtractions from those of one generation displayed by their descendants. As such, they form the closing chapters of the embryonic or growth-history of the modified generation.

[1] Philadelphia, 1869. "Proceedings Academy Natural Sciences, 1868."

In order to explain more fully the application of the above statements, I introduce a few examples selected from the subjects of my studies. Their number might be indefinitely extended. I first cite the genera of the tailless *Batrachia Anura* (frogs, toads, etc.), whose relations are very simple and clear, and show the parallelism between adult structure and embryonic succession. See above, 1 and 2.

The greater number of *Batrachia Anura* fall into two divisions, which differ only in the structure of the lower portion of their scapular arch, or shoulder girdle. In the one the opposite halves are capable of movements which contract or expand the capacity of the thorax; in the other the opposite halves abut against each other so as to be incapable of movement, thus preserving the size of the thoracic cavity. But during the early stages, the frogs of this division have the movable shoulder girdle which characterizes those of the other division, the consolidation contituting a modification superadded in attaining maturity. Furthermore, young *Anura* are toothless, and one section of the species with embryonic shoulder girdle never acquire teeth. So here we have a group which is imperfect in two points instead of one.

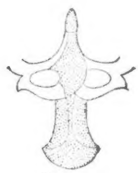


FIG. 1.

FIG. 2.

FIG. 3.

Shoulder girdles of *Anura*. Fig. 1, of the Arciferous type (*Scaphiopus holbrooki*). Fig. 2, *Rana temporaria*, tadpole with budding limbs. Fig. 3, do. adult. Figs. 2 and 3 from Parker.

This is the tribe *Bufoniformia;* the tribe with teeth and embryonic shoulder girdle is called the *Arcifera*, and that which is advanced in both these respects is the *Raniformia*. Now the frogs of each of these divisions present nearly similar scales of development of another part of the skeleton, viz: the bones of the top of the skull. We find some in which one of these bones (ethmoid) is represented by cartilage only, and the fronto-parietals and nasals are represented by only a narrow strip of bone each. In the next type the ethmoid is ossified; in the next, we have the fronto-parietal completely ossified, and the nasals range from nar-

row strips to complete roofs; in the fourth station on the line, these bones are rough, with a hyperostosis of their surfaces; and in the next set of species, this ossification fills the skin, which is thus no longer separable from the cranial bones; in the sixth form the ossification is extended so as to roof in the temporal muscles and enclose the orbits behind, while in the rare seventh and last stage, the tympanum is also enclosed behind by bone. Now all of these types are not found in all of the families of the *Anura*, but the greater number of them are. Six principal families, four of which belong to the *Arcifera*, are named in the diagram below, and three or four others might have been added. I do not give the names of the genera which are defined as above described, referring to the explanation of the cuts for them, but indicate them by the numbers on the left margin of the page, which correspond to those of the definitions above given. A zero mark signifies the absence or non-discovery of a generic type.

	Sternum embryonic.				Sternum complete.
	Bufoniformia.	Arcifera.			Raniformia.
	Bufonidæ.	Scaphiopidæ and Pelobatidæ.	Cystignathidæ.	Hylidæ.	Ranidæ.
1—	0	0	1	1	0
2—	2	2	2	2	0
3—	3	0	3	3	3
4—	4	4	4	4	4
5—	5	5	0	5	5
6—	6	6	6	6	0
7—	7	0	0	0	0

It is evident, from what has preceded, that a perfecting of the shoulder-girdle in any of the species of the Bufoniform and Arciferous columns, would place it in the series of *Raniformia*. An accession of teeth in a species of the division *Bufoniformia*, would make it one of the *Arcifera;* while a small amount of change in the ossification of the bones of the skull would transfer a species from one to another of the generic stations represented by the numbers of the columns from one to seven.

There are few groups where this law of parallelism is so readily observed among cotemporary types as the *Batrachia*, but it is none the less universal. The kind of parallelism usually observed is that in which there is only a partial resemblance between adults of certain animals and the young of others. This has been termed

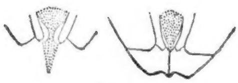


Fig. 2.

Fig. 3^3.

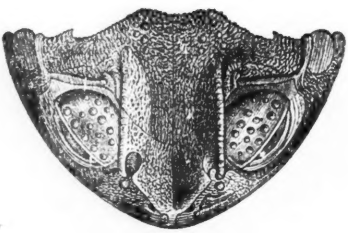


Fig. 6.

Fig. 7.

BUFONIDÆ.

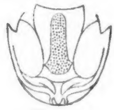


Fig. 2.

Fig. 3, wanting.

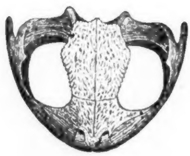


Fig. 5.

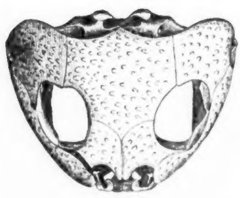


Fig. 6.

Fig. 7, wanting.

SCAPHIOPIDÆ AND *PELOBATIDÆ.*

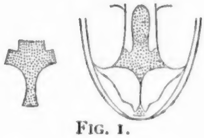


FIG. 1.

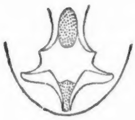


FIG. 2.

FIG. 2[1].

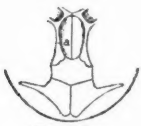


FIG. 3[2].

FIG. 6.

HYLIDÆ.

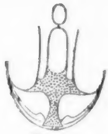


FIG. 1.

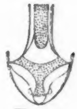


FIG. 2.

FIG. 3.

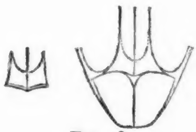


FIG. 3[3].

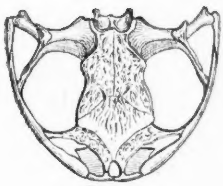


FIG. 4.

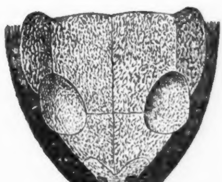


FIG. 6.

CYSTIGNATHIDÆ.

"inexact parallelism," and the relation is presented by forms not very nearly phylogenetically related. The more remote the phylogenetic lines of two types, the more "inexact" will their parallelism be. It was once a question whether any parallelism can be traced between the members of the five or six primary divisions of animals, and in my essay on the "Origin of Genera," I was compelled to state that there was then "no evidence of the community of origin of these divisions." Since that time, Haeckel has published his "Gastræa Theory." This is a grand generalization from the facts of embryology, which shows the community in type of the early stages of all animals, and the similarity of the phases which they present during a part of their larval life. The exceptions to this law which have been observed, will probably be explained, as have been those which have been urged against the law of homologies in anatomy.

FIG. 3_{-1}.

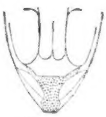


FIG. 3.

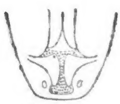


FIG. 3^1.

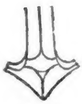


FIG. 3^2.

The palæontology of the *Batrachia Anura* is largely unknown, so we must look elsewhere for proof of the truth of the fourth proposition, viz., that the successional relation in embryology corresponds with that shown by palæontology to have existed in geologic time.

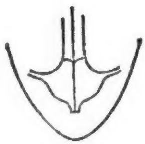


FIG. 3^3.

FIG. 5.
RANIDÆ.

For this purpose I select one of the most complete series known to palæontology; that of the camels or *Camelidæ*, whose remains are found abundantly in various parts of our country. The succession of the known genera is seen in the structure of the bones of the feet, and of the superior incisor and premolar teeth. The metatarsal and metacarpal bones are or are not coössified into a cannon bone; the first and second superior incisor teeth are present, rudimental or wanting, and the premolars number from four to one. The relations

which these conditions bear to geologic time is displayed in the following table, commencing with the lowest horizon:

	No cannon bone.	Cannon bone present.				
	Incisor teeth present.		Incisors one and two wanting.			
	4 premol'rs.			3 prem'rs.	2 prem's.	1 prem'r.
Lower Miocene.	*Poëbrotherium.*					
Upper Miocene.		*Protolabis.*	*Procamelus.*	*Pliauchenia.*		
Pliocene and Recent.					*Camelus.*	*Auchenia.*

This table shows that geological time has witnessed, in the history of the *Camelidæ*, the consolidation of the bones of the feet and a great reduction in the numbers of the incisor and premolar teeth. The embryonic history of these parts is as follows: In the fœtal state all the *Ruminantia* (to which the camels belong) have the cannon bones divided as in *Poëbrotherium;* they exhibit also incisor teeth, as in that genus and *Protolabis.* Very young recent camels have the additional premolar of *Pliauchenia.* They shed this tooth at an early period, but very rarely a camel is found in which the tooth persists. The anterior premolar of the normal *Camelus* is in like manner found in the young lama (*Auchenia*), but is shed long before the animal attains maturity. I may add that in some species of *Procamelus* caducous scales of enamel and dentine in shallow cavities represent the incisive dentition of *Protolabis.*

It remains to shows that characters of the kind above mentioned are sometimes inconstant; that they may or may not appear in individuals of a species. Under such circumstances it is evident that their origin does not imply any break in the line of descent.

First, as to a family character. It is well known that the deer differ from the giraffes in the presence of a burr or ring of osseous excressences surrounding the base of the horn. Now in the extinct tertiary genus *Cosoryx* there are three species which possess or lack this burr indifferently. Why some individuals should, and others should not possess it, is not known.

Second, as to a generic character. The genus *Canis* (dog) is defined by the presence of two tubercular molars in the inferior series. The allied genus *Thous*, possesses three such teeth, while

Icticyon has but one. Now examples of *Canis familiaris* (domestic dog) with but one tubercular molar are not rare, while an individual with three is occasionably found.

To take another case. The normal dentition of *Homo* (man) is, on each side, incisors, 2; canine, 1; premolars, 2; molars, 3. It is very common to find in the higher races, individuals who have molars only two in one or both jaws; and the absence of the external incisors of the upper jaw is almost as frequently met with. Here we have two new generic variations in one and the same species.

In specific characters variations are most familiar. Thus, the young of deer are generally spotted, and the adults are nearly uniform in coloration. Some deer (as the *Axis*) retain the spotted coloration throughout life, while an occasional spotted individual of unicolor species, is a violation of specific character by a failure to develop. The larvæ of some salamanders are of uniform coloration, and the adults spotted. The unicolor adults of the same species, not uncommonly met with, present examples of the same kind of variation.

Any biologist can select hundreds of similar cases from his special department of study.

II. The Laws of Evolution.

Having reviewed the reasons why the doctrine of evolution should be received as truth, I desire to give attention to the laws which may be made out by reference to its phenomena. Progress in this direction is difficult, owing to the natural impediments in the way of studying the history of the growth of living beings. We will, however, commence by examining more fully the phenomena with which we have to deal.

It is well understood that the world of animal life is a nicely adjusted equilibrium, maintained between each individual and its environment. This environment exerts forces both purely physical, and those exercised by other animals. Animals antagonize each other in procuring food, whether that food consist of vegetation or of other animals, but in the latter case the conflict is more severe. A similar competition exists among male animals in the matter of reproduction. These exhibitions of energy constitute the struggle for existence, which is the daily business of the living world. It is well understood, that in this struggle the individuals best provided with means of self-preser-

vation necessarily survive, while the weak in resources must disappear from the scene. Hence those which survive must display some especial fitness for existence under the circumstances of their environment, whatever they may be. So the "survival of the fittest" is believed to be a law of evolution, and the process by which it is brought about has been termed "natural selection." The works of Darwin and others have satisfied biologists that this is a *vera causa.*

Before the excellence of a machine can be tested, it must exist, and before man or nature selects the best, there must be at least two to choose from as alternatives. Furthermore it is exceedingly improbable that the nicely adapted machinery of animals should have come into existence without the operation of causes leading directly to that end. The doctrines of "selection" and "survival" plainly do not reach the kernel of evolution, which is, as I have long since pointed out, the question of "the origin of the fittest." The omission of this problem from the discussion of evolution, is to leave Hamlet out of the play to which he has given the name. The law by which structures originate is one thing; those by which they are restricted, directed, or destroyed, is another thing.

There are two kinds of evolution, progressive and retrogressive; or, to use expressions more free from objection, by addition of parts, and by substraction of parts. It is further evident that that animal which adds something to its structure which its parents did not possess, has grown more than they; while that which does not attain to all the characteristics of its ancestors has grown less than they. To express the change in the growth-history which constitutes the beginning of evolution, I have employed the terms "acceleration and retardation." Generally these expressions are literally exact, *i. e.*, there is an increased rate of growth in evolution by addition, and a decreased rate in evolution by subtraction; but this is not always the case, for some divisions of animals have increased the length of their growth-period without reference to evolution in structure. The terms express the phenomena figuratively, where not exact in the sense of time, and I believe they are sufficiently clear. The origin of the fittest is then a result of either acceleration or retardation. It is easy to perceive that a character which makes its appearance in a parent before or near to the breeding season is likely to be

transmitted to its descendants; so also a character which is lost near this time is likely to be wanting from the offspring. The causes of acceleration and retardation may next claim attention.

It is well known that the decomposition of the nutritive fluids within living animals gives rise, in the appropriate tissues, to exhibitions of different kinds of forces. These are, motion in all classes; heat in some only; in a still smaller number, electricity and light; in all, at certain times, growth-force or bathmism; in many, phrenism or mental or thought-force. These are all derived from equivalent amounts of chemical force which are liberated by the dissolution of protoplasm. This organic substance, consisting of CHON, undergoes retrograde metamorphosis, being resolved into the simpler CO_2, HO, etc., and necessarily liberates force in the process. None of the functions of animal life can be maintained without supplies of protoplasm. We have here to do with bathmism. It consists of the movement of material to, and its deposition in, certain definite portions of the growing egg, or fœtus, as the case may be. It is different in its movements in every species, and its direction is probably the resultant of a number of opposing strains. In the simplest animals its polar equilibrium is little disturbed, for these creatures consist of nearly globular masses of cells. As we ascend the scale a greater and more marked interference becomes apparent; radiated animals display energy in a number of radiating lines rather than in the spaces between them; and in longitudinal animals, a longitudinal axis exceeds all others in extent and importance. In the highest animals its results are much more evident at one extremity of the axis (head) than at the other, and the diverging lines are reduced to four (the limbs). In each species the movements of this force are uniform and habitual, and it is evident that the habit is so deeply seated that only a very strong dynamic interference can modify or divert it. The interfering forces are probably all those transmissible through living tissue, and especially molar force. Thus every species has its own specific kind of bathmic force.

The characters of living beings are either adaptive or non-adaptive; they are either machines especially fitted to meet the peculiarities of their environment, or they are not. Among the latter may be ranged rudimental structures and also many others

of no sufficient use. They are all due either to excess or defect of growth force; they are either consequences of a removal of nutritive material to other portions of the body; or they are due to an excess of such material which renders an organ or part useless through disproportionate size. Of the former class may be cited the absence of the tail in some monkeys and birds; also of the teeth in some Cetaceans; of the latter kind are the enormous tusks of the mammoth and the recurved superior canines of the babyrussa. The change of destination of this material has been probably due to the construction of adaptive machines whose perfection from time to time has required the use of larger and larger proportions of force and material.

In considering the origin of adaptive structures, two alternative propositions are presented to us. Did the occasion for its use follow the appearance of the structure, or did the need for the structure precede its appearance? The following answer to the question has always been the most intelligible to me. Animals and plants are dependent for existence on their environment. It is an every-day experience that changes in environment occur without any preparation for them on the part of living things. If the changes are very great, death is the result. It is evident that the influence of environment is brought to bear on life as it is, or has been, and that special adaptations to it on their part must follow, not precede changes of climate, topography, population, etc. We have another important consideration to add to this one, viz: the well-known influence of use, *i. e.*, motion, on nutrition. Exercise of an organ determines nutritive material to it, and the nervous or other influence which does this, equally determines nutritive material to localities in the body to which an effort to move is directed, whether an executive organ exist there or not. The habit of effort or use determining the nutritive habit must be inherited, and result in the growing young, in additional structure. Change of structure, denied to the adult on account of its fixity, will be realized in the growing or plastic condition of fœtal or infant life. The two considerations here brought forward lead me to think that the cause of acceleration, in many adaptive structures, is environment alone, or environment producing movements, which in turn modify structure. The character of the stimulus in the successive grades of life may be expressed by the following table, passing from the lowest to the highest:

1. Passive or motionless beings;
   by climate and food only.
2. Movable beings;
   by climate, food and motion.

   By motion either;

   a, unconscious, or[1]

   aa, conscious, which is,

   b, reflex, or

   bb, directed by desire without ratiocination, or

   bbb, by desire directed by reason.

The only general rules as to the direct influence of motion on structure which can be laid down at present are two, viz: That density of tissue is in direct ratio to pressure, up to a certain point;[2] and that excess of growth force, in a limited space, produces complications of the surfaces stimulated.[3] These and other laws, yet unknown, have probably led the changes expressed by evolution, while many others have followed the disturbance of equilibrium which they have produced.

I here allude incidentally to the question of transmission or inheritance. It has been maintained above that the bathmic force of each species is different from that of all other species. This force is characteristic of some unit of organization of living beings; and this probably consists of several molecules. This unit has been termed, by Haeckel, the plastidule. The transmission of the bathmic force of one generation to another would be effected by the transmission of one or more living plastidules; and this is probably precisely what is accomplished in reproduction. The *Dynamic Theory* of reproduction I proposed in 1871,[4] and it has been since adopted by Haeckel under the name of perigenesis. I compared the transmission of bathmic force to that of the phenomenon of combustion, which is a force conversion transmitted from substance to substance by contact. The recent observations of Hertwig, Bütschli and others, confirm this view. The theory of pangenesis, devised to explain the phenomenon of reproduction, is to my mind quite inadequate.

[1] Movements coming under this head are often called reflex.

[2] See *Penn Monthly*, 1872.

[3] "Method of Creation," Philadelphia, 1871.

[4] "Method of Creation," 1871.

EXPLANATION OF CUTS OF CRANIA OF ANURA.

The numbers in each column correspond with the types of ossification mentioned in the text, and are the same as those in the table of families given in the same connection. The power numbers attached to Fig. 3, represent the degree of ossification of the nasal bones, except the —1, which signifies unossified ethmoid. Most of the cuts are original.

BUFONIDÆ.—Fig. 2, anterior part of skull of *Chelydobatrachus gouldi* Gray, from Australia. Fig. 3, do of *Schismaderma carens* Smith, S. Africa. Fig. 6, top of head of *Peltaphryne peltacephala* D. and B., Cuba. Fig. 7, top of head of *Otaspis empusa* Cope, Cuba.

SCAPHIOPIDÆ AND PELOBATIDÆ.—Fig. 2, diagram of top of cranium of *Didocus calcaratus* Micahelles, Spain. Fig. 5, skull of *Scaphiopus holbrooki* Harl., United States. Fig. 6, skull of *Cultripes provincialis*, from France, after Dugès.

HYLIDÆ.—Fig. 1, *Thoropa misiessi* Bibr., Brazil. Fig, 2, *Hypsiboas doumerci* D. and B., Surinam. Fig. 2^1, *Hypsiboas punctatus* Schn., Brazil. Fig. 3^2, *Scytopis venulosus* Daudin, Brazil. Fig. 6, *Trachycephalus geographicus* D. and B., Brazil, after Steindachner.

CYSTIGNATHIDÆ.—Fig. 1, *Eusophus nebulosus* Gir., Chili. Fig. 2, *Borborocœtes tasmaniensis* Gthr., Tasmania. Fig. 3, *Elosia nasus* Licht., Brazil. Fig. 3^3, *Hylodes oxyrhynchus* D. and B., W. Indies. Fig. 4, *Grypiscus umbrinus* Cope, Brazil. Fig. 6, *Calyptocephalus gayi* D. & B., Chili.

RANIDÆ.—Fig. 3^1, *Ranula chrysoprasina* Cope, Costa Rica. Fig. 3, *Rana oxyrhyncha* Sund., S. Africa. Fig. 3^1, *Rana clamitans* Daud., N. America. Fig. 3^2, *Rana agilis* Mus., Berol. Fig. 3^3, *Rana hexadactyla* Less., India. Fig. 4, *Polypedates quadrilineatus* D. and B., Ceylon.

[*To be Continued.*]

——:o:——

CONCERNING AMBER.[1]

BY ERMINNIE A. SMITH.

THE history of amber illustrates most clearly not only the slow and tedious growth of civilization, but also the seeming perversity and obtuseness of human nature, which, especially in former times, so retarded the advancement of science. Exhuming this history from the dim, far distant, prehistoric past, we find that from being first used for fuel by the almost barbaric northern hordes, among the more refined southern peoples, amber, like bronzes and their other articles of luxury, took the place of coin and had its economical and financial import. The oldest written documents that have come to us, mention it as one of the chief articles of luxury of the ancient civilized world, an object of greater request than fine gold.

[1] Read before the "American Asso. for the Advancement of Science," at Saratoga, August, 1879.

Three thousand years ago it was well known among the inhabitants of Hellas that amber would attract light bodies, and Thales, one of the "seven wise men of Greece," adduced that circumstance in support of his theory that inanimate objects possessed souls, but two and a-half thousand years passed before it was discovered that it was this self-same power which, flashing amid the roar of thunder, illuminated the wide canopy of Heaven, bound iron to iron and directed the silently recurring course of the magnetic needle.

Tamed and chained as we have considered this all-pervading element, still, as day by day we are startled by new discoveries, and while awaiting the result of investigations which may transform the night of our great metropolis into day, are we not as puzzled that these problems should have remained so long unsolved as astonished at their solution ?

Americans can complacently pardon the inexplicable fact that Dr. Wall, the English scientist, when succeeding in drawing the electric spark from amber and hearing the crackling sound accompanying it, compared the two to thunder and lightning, but left the discovery of their being identical to our Benjamin Franklin, with his kite and key.

Although nearly two thousand years ago, Pliny wrote that amber was the fossil resin of the extinct Conifer, *Succinum pinites*, to-day the subject presents many unsolved problems. It is true the modern geological column has assigned it an approximate geological place, and modern chemistry has given it a formula, and its principal scientific value as the source of succinic acid and varnish.

A brief review of some established facts in regard to amber as also some of the erroneous but popularly received ideas, which, if unimportant, still remain uncorrected, will perhaps show that for a substance ever popular, coveted as a luxury, even ranking as a gem, both useful and ornamental, with a name in every language expressive of its many qualities, it has scarcely received the attention it deserves.

Probably the oldest of these names is *bernstein*, or its equivalent in the old Teutonic, from its combustibility. Its two Latin names are *succinum* (juice) and *lincurium*. In Persian it is called *körnbu*, or straw robber; in French the trivial name is also *tire de paille*, from its attracting straw; in Italian, Spanish and English

nearly the same name is given for amber, signifying cluster or mass. The first Greek name applied to it was a term signifying the rays of the sun, either from the color or some relation to the sun god. The popular Greek name was *electron*, or the attractor, and thus our substance can boast of having added a word to nearly every language, as even the mother-tongue-loving Germans find *electrität* more euphonious than their harsher synonym, *bernsteinkräftigungrüstzeug*.

Italy, Spain, France, Switzerland and England are given as amber-producing countries, but it must not be forgotten that under this name are included many fossil resins, the differences in which have as yet been hardly determined. In Lemburg, in the Tertiary sandstone, with giant oysters, a splendid amber is found in immensely large pieces, clearer than the Prussian, and producing a most delightful odor when burnt.

In the pitch coal of Bohemia, Reutz found specimens containing sulphur, and also with the foraminifera of the Vienna Tertiary. Daubré found amber in Alsace, and Schubert in the Alps, but these were of a different quality from that of the Baltic sea. But there is no doubt that this amber conifer forest reached from Holland over the German coast, through Siberia and Kamtschatka even to North America, and from the abundance of amber found in some localities, those conifers must have been as productive as is at present the *Dammara australis* of New Zealand, the twigs and branches of which are so laden with white resin as to have the appearance of being covered with icicles.

One of the great deposits of amber is in the Hauptvaterland, where on the plains of Pomerania the peasants dig in the surface clay for it. In the vicinity of Brandenburg, pieces have been found weighing four pounds.

From this abundance of amber in the drift clay and also from the fact that branches of "arbor vitæ" *(Thuja occidentalis)* occur in the Baltic amber, and have been found in the stomach of the mastodon in the United States, Göppert concluded that the "Diluvial," or time of the mammoth in the old world and mastodon in the new, was the age of amber.

This theory has since been entirely disproved.

By far the most celebrated locality for its richness in amber, and one which still possesses great stores of this valuable fossil, is the peninsula of Samland—a portion of Prussia nearly surrounded by the Baltic sea.

The northern part of this region, which constitutes the promontory of Brüsterort, is very hilly, and the coast banks are often from one hundred and fifty to three hundred feet high. Formerly this was all owned and worked by the German government, and was watched by *gens d'armes;* all amber found, even by the peasants in ploughing, being claimed, the finder, however, receiving one-tenth of its value. For the piece in the Berlin Museum, weighing eighteen pounds, the finder received a thousand dollars.

Until ten years ago, during stormy weather, when the waves were beaten against the banks of this coast, the amber was thrown up in quantities, entangled in the seaweeds, and a hundred hands were ever ready to intercept it with their nets, a trying occupation, as the roughest storms yielded the richest booty. Of late years the diving apparatus has been used so successfully that the marine deposit has been greatly diminished, and systematic mining is now carried on inland, where the amber is much finer.

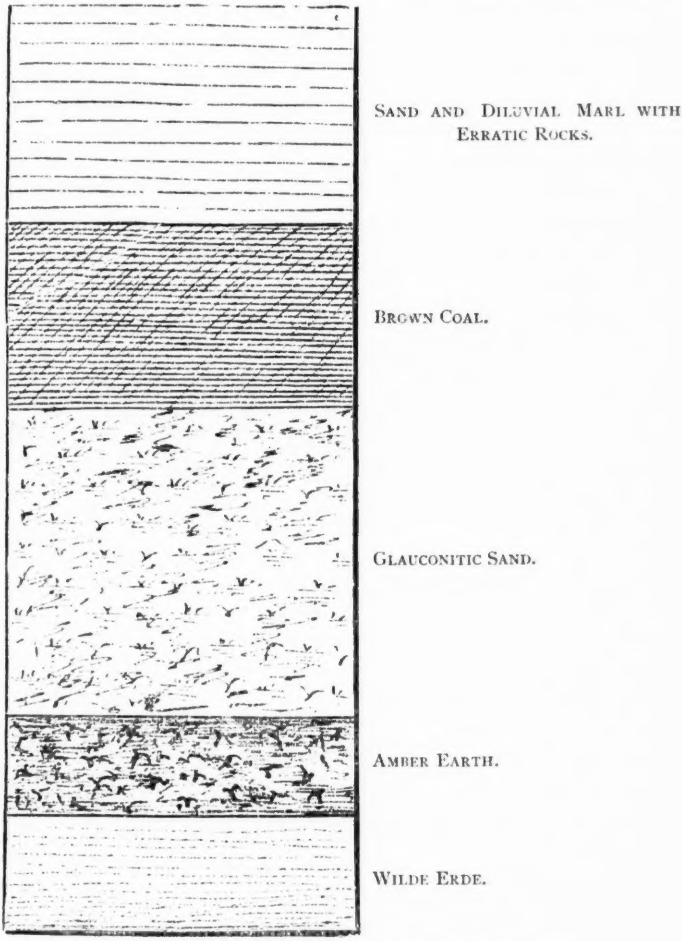
The price of amber has increased during the last year, and this advance is caused by the diminution of the yearly product, many of the pächters, or renters, having thrown up their contracts and abandoned the business of mining on that account.

It was in this famed locality of Samland, so favorable for geological survey that Prof. Zaddach of the University of Königsburg, pursued his investigations relating to the birthplace of amber, and his report throws great light upon this vexed question.

Taking a section of the cliffs where the geological structure is exposed, he finds that wherever the Tertiary formation crops out, it always comprises two different deposits. The underlying consisting of thick beds of glauconitic sand, which sometimes attains a height of sixty feet above the sea level, and upon this rest the beds of the Brown Coal formation, from sixty to a hundred feet thick. Under the green sand lies the so-called amber earth, only from four to six feet thick, and underneath this the "Wilde Erde," so called because containing no amber.

Sometimes the beds of green sand are cemented by hydrated oxyd of iron into a coarse sandstone which often contains well-preserved fossils representing the Tertiary period, but as this glauconitic sand is a marine formation, it follows that the amber it contains does not lie in its original bed—that is, not in the soil of the old forest in which the amber pines grew—but that the amber was washed into the sea in which sea urchins and crabs lived.

In the sand of the amber beds are found numerous pebbles or pieces of compact stone, which is evidently the parent rock of the green sand, as it is composed of exactly similar granules of



GEOLOGICAL SECTION OF THE AMBER COAST OF SAMLAND.

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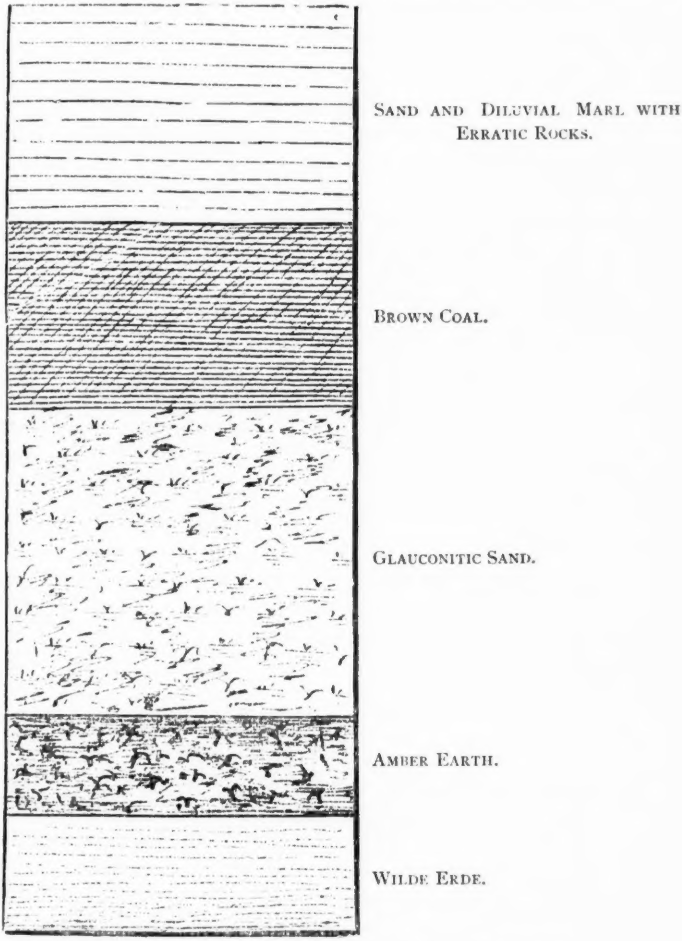

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tic, and belongs to the Cretaceous. It is therefore proved that the Tertiary glauconitic sand has been made up of the green sand of the Cretaceous formation. Therefore the trees yielding the amber resin must have grown upon the green sand beds of the Cretaceous which then formed the shores of the estuary where the lower division of the Tertiary accumulated. Zaddach assumes that at that time the coast sank slowly, and the forest soil being washed by the waves the amber was carried into the sea.

Immediately over these amber-producing strata rest the beds of the Brown Coal formation, the fossil plants of which differ entirely from the amber flora. Finally, Prussia was laid dry by an upheaval of the rocks, and this ended for a time the recorded history of the country.

Now ensued a new period in the geological history of Samland, when the climate and all the conditions of the country were changed. The mountains of the north which projected out of the sea were covered with glaciers that extended down to the water.

Icebergs laden with the finer débris of rocks and blocks of stone, were detached from these glaciers and drifted to the south, passing over land formed of Cretaceous strata. Without doubt there remained a considerable deposit of amber upon this green sand bed of the Cretaceous formation where the old forest soil still existed. By the icebergs this soil was now broken up and the amber brought down and scattered in every direction.

Thus the fact is explained that amber nests are found in the quaternary deposits over all the plains of northern Europe.

This epitome of Prof. Zaddach's report seems to settle the question as to the birthplace of amber in Germany, and contradicts entirely the generally received opinion that it is the product of the Brown Coal formation, and also the theory of Dr. Feuchtwänger, that marine amber was a later deposit or formation than terrestrial.

It is apparent that the gum of the amber trees flowed out as a viscid sap to which all small objects, leaves, twigs, insects, etc., that came in contact with it adhered. Subsequent exudation covered these and preserved them more perfectly than was possible by any other method. In this way vast numbers of insects were hermetically sealed up, over eight hundred species having been discovered and many groups yet remaining to be studied.

These give us much interesting information in regard not only

to the insect life of the amber age, but afford valuable information in regard to the history of many of our living species and groups (see Heer's description of amber insects). These species are now mostly extinct but have affinity with tropical forms. A very interesting collection of these most ancient mummies can be seen in the British Museum. A classic spider is at Amherst, and in my own collection is a lizard so perfectly embalmed that the animal tissues can be seen, as also the liquid contained in the stomach; this little curio has the honor of having been christened by Prof. Agassiz.

Prof. H. R. Goeppert has made a study of the remains of plants found in amber, and has identified one hundred and sixty-three species, all of which are now extinct. Mr. Kaldenberg, of New York, has specimens of amber containing bark, water and various insects.

After mining, amber is kept temporarily in vaults near the amber localities. Rosa narrates that he entered one of the vaults of the Pächter Douglas, where he saw the yearly products arranged according to their size and quality in chests and baskets, and saw records containing the yearly results back to 1500. The worth of the pieces varies according to the size and perfection.

For the trade it is divided into classes, the best pieces being generally sent in the rough to Constantinople, where they are used for the mouth-pieces of pipes, as it is still believed there that amber possesses properties preventing contagion, and as the pipes of this ease-loving people are lighted by domestics, the amber tips to the long stems are considered a prudent caution. This trade with Constantinople is very ancient and still continues over the same route as a thousand years ago.

The smaller sized pure pieces are used for beads and the very impure for the distillation of succinic acid, the residue or refuse is the *colophonium-succini* employed in the preparation of varnish. The varnish made from amber has long been considered the finest, but other resins are now its rivals, and varied are the secrets of this prosperous trade. With amateurs at work all over the land we may hope that even the secret of Stradivarius may yet come to light!

The chemical analyses of all resins, both fossil and recent, differ very slightly. Certain varieties of amber, copal, mastic, etc., giv-

ing nearly the same atomic ratio as will be seen from the following table :

	Carbon.	Hydrogen.	Oxygen.
Amber	10	8	1
Retinite	12	9	1
Copal	10	9	1
Mastic	10	8	1
Eliminite	10	8	1
Fiehtlite	8	6	1
Ambrite	16	13	1

The conclusion is that their differences consist in the arrangement of their molecules and not in their composition or even age.

Amber may be distinguished from the other resins by its hardness, its lesser brittleness and the much higher temperature required to reduce it, and also its greater electric action, but the difference is quickly discovered in the attempt to cut and polish, as the ordinary resins become in the process so heated and softened as in a measure to prevent their use for ornamental purposes. Copal jewelry is, however, occasionally made, but it soon loses its lustre.

A property of amber not generally known is its flexibility at certain temperatures. Formerly when amber required bending it was softened by placing it in warm linseed oil, and it could then be bent in to a required form. For changing the form of amber the method at present used in our extensive manufactory in this city, is simply to hold the amber over a lamp and draw it out slowly by hand. Although this process is very difficult and slow, the results are marvelous.

A pipe-stem nineteen inches long has been in this way drawn out of a coil of amber about six by four inches in size or fifteen inches in circumference.

At the same factory can be seen all the process of working amber which, owing to its low degree of hardness, is wrought with the turning lathe after having first been cut with a knife and filed into something approaching the form required. It is then polished in the lathe or by hand with pumice stone, whiting and alcohol. The chippings and amber dust left from the cutting are used for varish or incense. The Orientals, especially the Chinese, consider the burning of the odoriferous amber the highest mark of respect possible to pay a stranger or distinguished guest, and the more they burn the more marked is their expression of esteem.

We find in King's work on gems, the following: "A large amber cup, holding half a pint, has lately been discovered deposited in a tumulus in Ireland, which, from its size could hardly have been cut out of a single block of that substance. It has been ascertained by experiment that bits of amber boiled in turpentine can be reduced to a paste, united and molded into any form desired."

In Feuchtwänger on gems, we also find similar assertions regarding the melting and reforming of amber. Both King and Feuchtwänger are in error on this point. If amber were ever thus melted and molded, the art has certainly been lost.

Repeated experiments have failed to produce such a result, although a recent German scientific journal informs us that a patent for such a discovery has been applied for. An art so valuable, if successful, would certainly insure a fortune to the inventor. Nor is it necessary to have recourse to such a theory in order to account for the cup exhumed from the Irish tumulus. Alexander, Czar of all the Russians, owns a tea-set cut from blocks of this precious material. I have seen rough specimens both in the Berlin and Vienna museums larger than would have been required for the cup alluded to.

The imitations of amber are various. Glass paste is sometimes used, another composition is of turpentine and caoutchouc, still another, linseed oil, gum mastic and litharge, to which finely powdered copal is added to give the appearance of veins, add to this, ants of decalcomania, and we have the material of the cigar-holders which so deceived the uninitiated during our exhibition at Philadelphia. The most perfect imitation is the uncolored celluloid. Abbé Haüy gives the following mode of detecting or identifying amber: "Attach a fragment to a knife, and when inflamed the amber will burn with some noise and ebulition, but without liquifying so as to flow, whereas all other resins and compositions melt and drop." A better method is perhaps the electrometer.

Very little amber has as yet been found in the United States. Gay Head, Martha's Vineyard, Camden, N. J., and Cape Sablé only are mentioned as its localities. A barrel full of small pieces was taken out of the green sand in New Jersey, which through some mistake was burned.

Let us hope for the accident which may yet reveal to us hidden

stores of this interesting substance with a less primitive fate in reserve for it.

While the color of amber is generally yellow it occurs in all shades, from pure white to "black." The *Falernian*, from the wine of that name, was the favorite color among the Romans. Dice of the white variety are hardly distinguishable from ivory.

At Constantinople a pipe-stem of the milk-white variety is prized by the Turks at from forty to a hundred dollars. The action of sulphuric acid on the yellow changes it to red. A beautiful specimen of green amber has been found on the American coast. "Black amber," which was a vexed question in the middle ages, returns to question us again to-day. Monsieur le Conte de Borch, in his letters from Sicily, within the last decade, says that "black amber is common."

Stretter, the latest English authority on gems, also gives black amber; but a very careful analysis of the black amber which has recently been imported from Spain to be manufactured in New York, gives: Carbon, 82.57; hydrogen, 7.70; oxygen and nitrogen, 9.08; ash, .65. A result so different from true amber, and on distillation yielding no succinic acid, is, therefore, not true amber, but either a superior variety of jet or a highly oxidized bitumen. In chemical composition it seems to occupy an intermediate position between cannel coal and torbanite.

Subjected to the microscope, woody fibre is visible, replaced in part by resin. Its electric power is great, and admitting as it does of a remarkable polish, its lightness well adapts it for ornamental purposes.

Among the old accounts of journeyings in search of amber, we find the first mention of the Teutons as a race. As the search for an "El Dorado" led to voyages of discovery in later times, so we find that voyages and pilgrimages to the land of amber were made dating back to 1500 years before Christ. Peschel says, "Preach aloud the fact that the migrations of nations depend on the existence of the substantial treasures of the earth." So this Prussian paradise had been visited by Pythias of Massilena four hundred years before Christ, also by Theophrastus, the naturalist and philosopher, and by Philomen, the Greek poet. Nero sent there his Roman knights, who brought back quantities of amber to enrich his treasury, and a small image in this precious material was valued higher than a human slave.

Amber was intermingled with the myths and religion of the Greeks, their legends ascribing its origin to

> "* * * * the sweet tears shed
> By fair Heliades—Apollo's daughters,
> When their rash brother down the welkin sped,
> Lashing his father's sun team, and fell dead
> In Euxine waters."

Amber literature is of great interest to the virtuoso. Books in all languages refer to its many supposed qualities, and the insects contained in it have given rise to many quaint metaphors which still exist. Martial (A. D. 43) wrote in Latin: "The bee is inclosed and shines preserved in a tear of the sisters of Phæton, so it seems enshrined in its own nectar. It has obtained a worthy reward for its great toils—we may suppose that the bee itself would have desired such a death."

Thomas May (1640) thus translates this:

> "Here shines a bee, inclosed in an amber tomb,
> As if interred in her own honey comb—
> A fit reward fate to her labors gave,
> No other death would she have wished to have."

Hay in the same century translates it thus:

> "The bee inclosed and through the amber shown,
> Seems buried in a juice that was her own;
> So honored was a life in labor spent,
> Such might she wish to have her monument."

Sir John Denham (1640) wrote of streams,

> "Whose foam is amber and whose gravel gold."

In the Nibelungen Lied we find Hagentronje with his amber girdle; the dragon's blood armor of Siegfried is also supposed to have been amber; and Brunhilde mentions the amber-colored flower.

Byron alludes to amber in the "Island," and Pope speaking of Sir Plume,

> "Of amber snuff-box justly vain."

Also in his prologue to the satires,

> "Pretty in amber to observe the forms
> Of flies and ants and bees and bugs and worms;
> The things we know are neither rich nor rare,
> But wonder how the d—l they got there."

Milton apostrophizes a bee in amber, and Moore revels in amber imagery.

Modern authors have written of the weird "amber witch," and of "amber gods," and to-day a lizard in amber is thus addressed:

"Who pinioned thy grotesque and uncouth frame
Within the sunshine of this golden chamber?
Is this the fountain whence the nectar came?
Or is it star born, this undying flame
Which men call amber?

"Splay-footed sprawler from the unknown seas,
Oh, tawny cousin of the Ichthyosaurus—
What sportive sister of Hesperides,
In the ambrosia of celestial trees,
Embalmed thee for us?"

So questions the poet, but if we might invoke this "Ancient Mariner" from out his crystal coffin, more serious would be the questions we would bid him solve.

But though speechless, he bears a silent witness, for as one of the many hieroglyphics of the language of geology, underneath its Rosetta wand, he helps to reveal the history of our earth.

Thrice happy the gifted mortal, who, wielding this magic wand, can lift the veil and translate these mystic symbols of the too long "dusky past."

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— We recommend to the attention of members of the National Congress who are interested in the intellectual progress of the country, the character of the tariff on specimens, apparatus and books necessary for instruction in the sciences. These objects are only allowed to enter the country free of duty when *not intended for sale.* This practically prohibits any but wealthy citizens and institutions from possessing collections of the natural products of all parts of the earth excepting the United States, a restriction extremely disadvantageous in all directions. The majority of American students are not able to visit Europe for the purpose of making purchases, nor are they able to pay the increased rates which must be demanded by dealers who should bring their specimens here. The result is that foreign collections from all parts of the world pass by our country to go to the various European cities, large and small. This is one of the causes to which we can ascribe the ignorance of natural history which is so general in American Society as compared with that of Germany and some other parts of Europe. The amount of revenue derived from such importations must be practically nothing, while the

injury to useful pursuits and amusements is great. All such objects should be allowed to enter the country free of duty.

—— It has again become the unpleasant duty of the Philadelphia Board of Education to report where and how another reduction of the salaries of the teachers shall be made. We had hoped that they would have reported that no reduction was practicable. Philadelphia has long enjoyed the unenviable preëminence of paying its teachers less than any city of importance in the country. It is true that owing to the exigencies of the times two or three years ago, the salaries were lowered in several of our cities, but now that times have changed, the original rates should be restored. Instead of this our city governors wish to reduce the figures still lower. If the former situation was discreditable, what shall we say of the present movement? Councilmen perhaps do not know that teachers have a market value like any other kind of skilled labor, and that the city will get exactly what it pays for; also that they can in consequence produce such a community as they pay for. If they will only employ poor workmen, or a large percentage of such, they will turn out a community which will become the ready victims of all the evils that mental development and training is able to prevent, and which will not produce those intellectual fruits and flowers which so sustain and beautify human life. Not but that we have many excellent workmen in our corps of teachers to-day, but how long can we expect them to remain in a locality or even a profession where they are subjected to such vicissitudes. The character of the profession must inevitably deteriorate in every way under the present system.

The work of conscientious teachers under such circumstances has been, and is, missionary work, and their recompense the consciousness of awaking interest in matters tending to benefit thousands of pupils and teachers immediately and directly, and of affecting the community to be made up of these pupils in the future. The interest and zeal and energy of many of the teachers have been strong—sufficiently strong to carry them along in spite of opposition and obstacles always designed to prevent innovations and reforms. After a time came a reduction of seven-eights per cent. or $125 in their salaries. At the end of next year the scale of salaries will reduce their salaries again about $125, and now comes a reduction amounting to eight-twelfths per cent. or about $150. One of the consequences has been that one after another of these earnest teachers has lost heart and has dropped out, leaving the proposed plans to be worked out by somebody else, or to be dropped altogether. Their efforts have not been appreciated as they should be. If they are not compensated for their regular school work, why should they do more work for less pay? Why not render service commensurate with the wages paid?

Why increase cares and anxiety? Why not let things move along as best they may? WHAT IS THE USE?

We fear that a feeling of apathy may fall upon the stronger and more zealous teachers, as it has already seized upon the average teacher, and is always found with the idle, careless, or incompetent ones.

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RECENT LITERATURE.

DANA'S MANUAL OF GEOLOGY, THIRD EDITION.[1]—The merits of this work as a school-book are well known, and in the present edition they are decidedly enhanced. This is partly due to the introduction of the latest determinations in stratigraphic geology in the West. We observe with pleasure that Prof. Dana has adhered with impartial justice to the law of priority in the nomenclature of the formations of the interior of the continent, in spite of the attempts made by some writers to introduce names of their own, regardless of this necessary safeguard. The value of the work is also increased by the introduction of additional engravings, especially of those representing some of Prof. Marsh's discoveries in the West. It is true the author might have derived some aid from other sources, especially as regards the skull of *Coryphodon*, of which he gives a figure which is quite inaccurate.

We cannot speak in as high terms of the manner in which the palæontology of Vertebrata is represented in the new edition of the manual. It displays little acquaintance with what has been done in this field in North America since 1872, and that includes three-fourths of the entire subject. Thus the greater part of all the principal modern discoveries in the Permian, Triassic, Postcretaceous, Suessonian and Pliocene faunæ are not alluded to, while not a few of those in the Jurassic and Suessonian formations are attributed to other than the original discoverers. The nomenclature employed is that of the vertebrate palæontological papers published in the *American Journal of Science and Arts*, which is notoriously regardless of the rule that names must be only proposed to represent work done, and may not be proposed to secure credit for work yet *to be done*. It is discouraging to the student to be expected to remember names which cannot be used either because they are synonymes or do not refer to necessary descriptions.

THE REFUTATION OF DARWINISM.[2]—This book is an excellent illustration, if one were needed, of the futility of persons writing on the question of evolution who are not themselves experts in

[1] *Manual of Geology*, etc., with especial reference to American Geological History. New York, Ivison, Blakeman, Taylor & Co., 1880.

[2] *The Refutation of Darwinism, and the converse theory of Development, based exclusively upon Darwin's facts, etc.* By T. WARREN O'NEILL, member of the Philadelphia Bar. J. B. Lippincott & Co., 1880.

some branch of natural science. A work founded "exclusively upon Darwin's facts," must of necessity strike wide of the mark, for many of the most important evidences for evolution are not to be found, or are barely mentioned in Darwin's works. That Darwinism is not the whole doctrine of evolution is perceived clearly enough by Mr. O'Neill, who devotes two or three opening chapters to a lucid exposition of the well known fact that Natural Selection does not explain the origin of characters. This truth has for twelve years been maintained by the editors of this journal, as well as by others, and has been epitomized in the statement that "the origin of the fittest" is the primary problem of evolution, while the "survival of the fittest" (Darwinism) is secondary.

Mr. O'Neill's "Refutation of Darwinism," however, consists principally of a theory of his own, which is an extension of the principle of reversion to all kinds of variation now observed in domesticated animals; he does not concern himself so much with the wild ones, as they are not so fully considered in Darwin's works. In brief, Mr. O'Neill believes that the present condition of animals is one of degradation from a condition of primitive perfection, which has been brought about by the severity of the struggle for existence! The whole theory is a readaptation of modern knowledge to the mediæval idea of the creation and its degradation, consequent on the fall of man.

There are two little difficulties in the way of this hypothesis. Firstly: since the doctrine of evolution is an attempted explanation of the "origin of species," etc., etc., Mr. O'Neill's work is entirely irrelevant, if true. By reversion he only brings us back to species in their pristine completeness or "physiological integrity," as he calls it; the question of how they attained this condition is not considered. It is fair to add that Mr. O'Neill promises us a work on this subject in a foot note on page 435, which will be, if the author's expectations are realized, a wonderful work indeed.

The second difficulty is presented by the science of palæontology. One should look here for the evidences of reversion to older types, should such have been the law of the later creation. But Mr. O'Neill does not concern himself with this subject. When he does so he will find his primitive "physiological integrity" to be a myth; that development is by divergent advances, not by reversion; and that a struggle for existence, not too severe, has been an agent of good, not of evil.

The book is written in a pleasant style and the author is sometimes witty at Mr. Darwin's expense.

Hallez's Natural History of Turbellarian Worms.[1]—The first of this series was the elaborate researches on the embryology

[1] *Travaux de l'Institut Zoologique de Lille et de la Station maritime de Wimereux.* Fascicule II. Contributions a l'histoire naturelle des Turbellariés. Par Paul Hallez. Lille, 1879. 4to, pp. 213, 11 plates.

of Bryozoa, by J. Barrois; the present memoir is concerned with the structure of several Turbellarian worms, and is particularly valuable as giving detailed and well illustrated life histories of *Eurylepta auriculata, Leptoplana tremellaris,* with fragmentary but still important embryological details on certain Rhabdocœlous worms, with especial reference to the early history of the egg. He describes the lasso cells of some of the worms, remarkably like those of the jelly-fish, and discusses the process of strobilation in a Microstomum.

WESTWOOD'S SYNOPSIS OF URANIIDÆ.[1]—This is a finely illustrated essay on the systematic position of this small but interesting group of moths. By Guenée they were placed at the head of the Phalænidæ, in which view he was followed by Packard. Prof. Westwood, however, on account of differences in the venation of the wings, and the fact that the larvæ are not loopers, but have sixteen legs instead, or fourteen as with a very few Geometiid larvæ, believes that the group should be placed at a distance from the Geometridæ and amongst the Bombycidæ.

THE ZOÖLOGICAL RECORD FOR 1877.[2]—This well known publication of the Zoölogical Record Association, and which has now become almost absolutely indispensable to working naturalists, deserves more than a mere passing notice. Under the heads of twenty-two classes and orders, the progress of Zoölogy for the year past in all departments is reviewed by specialists competent, from their bibliographical attainments and training in their respective departments, to carry out the work satisfactorily. Under each head the contents of the more important papers, general and special, are given with references to their place of publication. The mammalia have been done by Edward Richard Alston; Aves, by Howard Saunders; Reptilia and Pisces, by A. W. E. O'Shaughnessy; Mollusca and Molluscoida, by Prof. Edward von Martens; Crustacea, by Prof. von Martens; Arachnida and Myriopoda, by Rev. O. P. Cambridge; Insecta, general subject, by E. C. Rye, together with Coleoptera, Hymenoptera, Diptera and Rhynchota; Lepidoptera, by W. F. Kirby; Neuroptera and Orthoptera, by R. McLachlan; Vermes, by F. Jeffrey Bell; Echinodermata and Cœlenterata, by C. F. Lütken; Spongida and Protozoa, by Stuart O. Ridley. Most of these names are exceedingly familiar to naturalists and are a sufficient guarantee of the character of the book. It is a work which may be deservedly encour-

[1] *Observations on the Uraniidæ, a family of Lepidopterous Insects, with a Synopsis of the Family and a Monograph of Coronidia, one of the genera of which it is composed.* By J. O. WESTWOOD. (From the Transactions of the Zoölogical Society, X, Part XII, 1879.) June 1st, 4to, pp. 35, 3 plates.

[2] *The Zoölogical Record* for 1877; being volume fourteenth of the Record of Zoölogical Literature. Edited by Edward Caldwell Rye, F. Z. S., M. E. S., etc., 8vo., pp. 24, 59, 11, 30, 97, 36, 20, 1, 234, 20, 11, 18, 8, 12, London, John Van Voorst, Paternoster Row, 1879.

aged. The subscription price of the annual volumes is £1, 10s, to the public.

LEIDY'S RHIZOPODS OF NORTH AMERICA.[1]—This magnificent volume, with its wealth of illustration, is the fruits of four years of constant study of the fresh-water Rhizopods of this country. The author has not only studied them in the Western Territories, but also at various points along the Atlantic coast from Nova Scotia to Philadelphia. The Rhizopods are the lowest forms of life with the exception of the Monera of Haeckel, of which but a single species has been detected by Prof. Leidy in this country. As a full and thoroughly well illustrated account of these organism this volume will prove of service to the general public interested in the discussions regarding protoplasm, for here are pictured with wonderful accuracy and grace these animated bits of protoplasm; to the teacher, who cannot always command even a single Amœba and much less a series of them, here is presented on a single plate the *Amœba proteus* in a dozen different attitudes, drawn in colors, in some cases half as large as one's hand; and this plate is succeeded by forty-seven colored chromo-lithographs, well engraved, though we doubt not falling far short of the exquisite original sketches of the author, who is not excelled by any living naturalist or zöological artist in the accuracy and artistic finish of his drawings.

Moreover the study of these minute changeable protean forms is most difficult in itself, and their truthful representation still more so. While, then, the volume has a high philosophical and educational value, it will stimulate naturalists to cultivate this field, and to elucidate the modes of development of these forms. To the palæontologist the work will have a high value, since allied or possibly the same shelled forms may be discovered in the lake formations of the Western Territories. This work forms, consequently, one of the most important volumes of final reports of the great survey now unfortunately closed, and which has done so much to spread among our people a knowledge of the natural resources of the Western Territories. Biology embraces palæontology, the latter is more than half of geology, so that no scientific geological survey can do its work properly without reference to these sciences. The cost to the survey of the field work, the press-work, and, we believe, the illustrations of this volume were but nominal, the printing of the volume with the necessary illustrations having been separately ordered by Congress. As the author states, "Whatever may be thought of the pertinence of publishing such works as the present one with the Reports of the Geological Survey of the Territories, to remove any misapprehension in the matter I deem it proper to state that my contributions have been

[1] *Report of the United States Geological Survey of the Territories.* Vol. XII, F. V. Hayden, in charge. Fresh-water Rhizopods of North America. By JOSEPH LEIDY, M.D. Washington, 1879. 4to, pp. 324, 48 plates.

given without pecuniary recompense. In my own judgment, Prof. Hayden has acted with the most enlightened view in authorizing and encouraging such natural history investigations as would be facilitated by explorations of the country in which his geological surveys were conducted. With the exception of the cost of publishing the present report, the only additional expense to which I put the survey during my explorations in the West amounted to about $222." The same may be said of at least one other of the bulky quarto volumes of the survey, and we suppose of others.

The number of species of these fresh-water Rhizopods living in our country is unexpectedly large; numbers of them are common to Europe and North America, and many are found not only in the Eastern States but also in the lakes of the Uintah mountains of Wyoming, showing that the forms are well nigh cosmopolitan. They occur in the summer time on the under side of floating leaves of water plants and especially among Sphagnum moss. "A drop of water squeezed from a little pinch of bog-moss has often yielded scores of half a dozen genera and a greater number of species."

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GENERAL NOTES.

BOTANY.

Sexual Differentiation in Epigæa repens.[1]—The following remarks on *Epigæa repens* are contained in Gray's "Synoptical Flora of North America," under the generic description of that plant:

"The flowers are heteromorphous and inclined to be diœcious, or diœcio-dimorphous. Those with fully polliniferous anthers seldom set fruit; their stigmas short, erect, slightly projecting beyond the margin of the five-toothed ring (to the teeth of which they are severally adnate), the style sometimes longer than the stamens and projecting, sometimes shorter and included. Fully fertile flowers on other plants; their styles (as in the former sort sometimes long and exserted, sometimes shorter and included) with stigmas elongated and much surpassing the ring, short, linear, glutinous, radiately divergent; their stamens either slightly polliniferous, or reduced to abortive filaments, or even wanting."

In the early spring of this year I took occasion to make some careful observations on this plant as it occurs in the vicinity of Washington City, the results of which, though in the main confirmatory of this description, differ from it in some respects, and afford some additional facts of special interest.

I desire to premise that these variances and additional peculiarities are doubtless due to differences of habit in different localities, and not to any lack of fidelity in description.

The principal deviation which I detected from the description which I have quoted, was in the styles and stigmas. I found no heterostyly; the length of the styles relatively to the flowers was about the same at all times in both forms of flowers. The stigma, however, presented a very different appearance in one form from what it did in the other. In the fertile form, in which the abortive stamens varied in all degrees, the lobes of the style were strongly divergent and of a firm texture, with evident stigmatic surfaces. In the staminate form they were never separated, but cohered tightly in an apparently solid club-shaped summit or head. I was able, however, to dissect them apart without

[1] Read before the American Association for the Advancement of Science, at Saratoga, N. Y., September 1, 1879, by Lester F. Ward, A.M.

lesion, and satisfy myself that they were entirely functionless, possessing no stigmatic surfaces.

The important *addition* which my observations furnished to the facts described by Prof. Gray, consisted in the discovery that the dimorphism of the flowers extends in a marked degree to their *dimensions*. The staminate flowers are, in all respects, much larger than the fertile ones. As this fact at first appeared quite remarkable, I took great pains to verify it, making my comparisons from specimens taken from localities widely separated, and repeating the observations a great many times throughout the flowering season of the plant. It grows on gravelly slopes in small areas or patches, and all the flowers in a patch were invariably found to be of the same kind, either all staminate or all fertile, as if all came from the same root, as no doubt they do.

The amount of surface covered by staminate plants was found greatly to exceed that covered by the fertile ones. It thus often required considerable search to find a patch of fertile flowers, but a little practice was sufficient to render their detection easy from the diminished size and conspicuousness of the flowers. This difference does not consist merely in the greater vigor and turgidity of the staminate form, but represents an actual discrepancy in the measurements of all the parts of the flower, amounting to about thirty per cent. in the length and about forty per cent. in the width of the corolla. The exact dimensions, as taken from typical specimens, were as follows:

Length of flower including calyx and limb of corolla:	
In staminate form	16 millimeters.
In fertile form	12 "
Width of corolla tube split through and laid open:	
In staminate form	11 "
In fertile form	7 "
Width of limb of corolla laid open in the same manner:	
In staminate form	15 "
In fertile form	9 "
Length of the pistil, including ovary and stigma:	
In staminate form	9 "
In fertile form	7 "
Length of perfect stamens	9 "
Length of sterile filaments	3 "

The staminate form appears never to develop fruit, although the ovary contains ovules. The fertile form, besides being much more rare in actual amount at flowering time, and possessing decidedly less fragrance, also often fails to fruit. It is, therefore, only quite rarely that fruiting specimens can be found. I attribute this, however, to the failure of most of the fertile flowers to receive any pollen. The two forms are often not in close proximity. They bloom very early in the spring, before most of the flying insects appear. The flowers are always close to the ground, with their open end more frequently inclining downward than upward, and most of them are concealed under the foliage so as to

be invisible from above. Yet, as we have seen, their self-fertilization is impossible. These and other facts have led me to the conclusion that, where fertilized at all, it is chiefly done by ants, which, on the theory, now generally accepted by entomologists, of the possession by that insect of a keen sense of smell, would sufficiently account for the exquisite fragrance of the flowers of Epigæa. I have failed entirely to find insects within the corolla, but this, so far from causing doubts that it is fertilized by insect agency, simply helps us to understand why it bears fruit so sparingly.

The facts which I have stated, even if they were entirely new, which they probably are not, might not, perhaps, in themselves have justified me in claiming for them the attention of this association. For my own part I am far more interested in the important principles which they illustrate, and it is for the purpose of stating these principles, supported by such an example, that I have been led to present the facts.

Besides affording an instructive example of the many ways in which plants are dependent upon insects, Epigæa well illustrates the process of sexual differentiation which is going on in a great many species of plants. In the maples it has not yet advanced so far; in Smilax it has gone somewhat farther, while in the willow it has reached completeness. It is in these intermediate stages that the phenomena are most interesting, and the botanist, contemplating a great number of these, differing by small degrees, can almost see the process in operation. The phenomena of dimorphism, as it exists in Houstonia, must probably be regarded as one of the initial steps in the direction of ultimate diœcism, or complete separation of the sexes.

In this respect, as in many others, we find that nature cannot be assumed to have reached its final and fixed condition, but that the existing state of things must be regarded as dynamic; the movements in the past which have made things what they are, still continue to effect changes in them. There is a sort of *uniformitarianism* in biology as well as in geology, and the law of "present causes" is as potent in explaining the existing condition of plants and animals as it is that of coast lines or mountains.

Hermaphroditism, or self-fecundation, seems to be a thraldom necessary at the outset, but from which all living things are seeking to escape. The animal kingdom has, for the most part, thrown off this yoke, chiefly through the development of the sexual instinct. The vegetable world still groans heavily under it, but it is now looking to insects as its liberators, and the little flower which I have figured here, shows one of the many ways in which these creatures perform this service.

THE AGENCY OF INSECTS IN FERTILIZATION.[1]—I present some additional notes taken from papers prepared by some of my young students while working under my direction.

Mr. A. J. Chappell studied a healthy plant of *Lythrum salicaria*. The flowers of the species are trimorphous. The plant studied was one which produced short stamens and those of medium length and a long style. In the bed, these organs are bent or curved so that the anthers and stigmas are included within the calyx. The anthers all ripen at about the same time, sometimes before the flower opens.

Bees visit the plant freely. Their heads are covered with pollen from the stamens; the thorax with pollen from the stamens of medium length.

Some of the pollen thus collected on the insect is carried to the long pistils. Pollen was found on all the stigmas, but Mr. Chappell observed *that after a few days each pistil in turn after the flower had opened, wilted and fell off.*

Mr. E. A. Murphy found several kinds of insects about the Lythrum above mentioned. He was also surprised to see all the pistils, after they had been exposed for a few days, wilt and fall off. The plant was making a fair growth, and did not suffer from dry weather or a surplus of moisture.

Mr. J. T. Elliott studied *Apocynum androsæmifolium*. The anthers are shaped somewhat like an arrow-point. All the anthers form a sort of pyramid about the pistils. An abundance of honey attracts many insects. The groove between the lobes of the anthers often catch and hold small bees by the tongue, much as a tapering crack between two boards would hold a rope. Small wild bees pull out the masses of pollen which come in pairs.

Some flowers were tied up to keep all insects away. In some cases after a few days, the bell-shaped corolla was full and overflowing with nectar. These were artificially fertilized, some with pollen of the same flower; others with pollen from other flowers. Some were kept covered without artificial aid in transferring pollen. All were covered again. Those pistils where the stigmas were supplied with pollen set fruit.

Mr. W. A. Burgess tried similar experiments with similar results.

Mr. J. H. Irish observed the flowers of catmint. When the anthers are discharging their pollen, they are clustered around and a little above the pistil. When the pistil is ready to secure the pollen, it reaches above the stamens and spreads its stigmas apart. At this time the anthers are dead and slightly curled down. The stigmas are just in position to touch the back of an insect where it has previously collected pollen from anthers of a younger flower.

[1] Notes from some of the papers of students at Michigan Agricultural College. Abstracts made by Prof. W. J. Beal.

In several cases, flowers were tied up with sarles which kept insects away. No seeds set.

Insects fertilize *Nepeta nuda* in the same manner as they do the catmint.

Mr. Geo. Young found that the flowers of *Nepeta mussini* were also proterandrous and that they were fertilized essentially in the same way as the two species above mentioned. He sprinkled some chalk dust on the back of a bee and soon found that it had come back for more honey. *Salvia Japonica, Teucrium Canadense,* thyme, and motherwort were fertilized in the same manner.

A number of spikes of *Teucrium* before flowering were tied up in bags. None of these set seeds. Other spikes were tied up in a similar way. The latter were several times violently shaken without taking off the covers. This caused about one-fifth of the flowers to set seeds.

The fertilization of *Plantago lanceolata* and *P. major* have before been described. The flowers are in spikes. The pistils appear some time before the stamens which are long and reach some distance up the spike. The pollen is dry and the plant is usually described as dependent on the wind for aid in transferring from one flower to another.

Several students have seen honey bees and other wild bees, bugs and flies in considerable numbers about the flowers of *Plantago lanceolata.* These insects, except the bugs, seem to be after the pollen.

Mr. Avery covered buds of *Asclepias cornuti* and they set no fruit. Not all insects about this plant aid in the fertilization. He saw some insects held fast by pollen which they were not stout enough to pull out. Some left their legs and had escaped. Ants get fast sometimes. They were seen to liberate their feet with their jaws.

Mr. L. Wilcox found the flowers of the common teasel proterandrous and dependent on various insects for fertilization.

Mr. H. I. Penoyer finds that the flowers of *Mimulus ringens* are not self-fertilizing but depend on the aid of insects. Detailed experiments were made to prove the statement.

Mr. J. E. Coulter removed the young stamens from flowers of *Scrophularia nodosa* and found that the pistils were fertilized in some way by receiving pollen from other flowers. He also tied up some flowers with paper bags and found that they did not set fruit. Mr. J. R. Shelton removed the stamens from five opening buds, and tied over them a paper bag. After a few days they began to enlarge and develop seeds. He covered five buds not artificially fertilized and they set no fruit. This plant is proterandrous and well described and illustrated in Dr. Gray's neat little book, " How Plants Behave."

Mr. W. E. Hale found that the flower buds of *Campanula rotundifolia* all blasted if tied in paper sacks. It has often been

shown that the stamens shed their pollen on the outside of the style before the stigmas are open.

Mr. W. H. Goss tied paper sacks about flowers of *Lobelia spicata*; none of them bore seeds. From others he cut away the young anthers while very small. The latter were left exposed and all fruited.

Mr. C. A. Ward, on the flowers of *Martynia proboscidia* has seen bumble bees, honey bees and another wild bee. Bumble bees were seen to enter the flowers. The stigmas closed before the bees backed out. The quickest time observed for the closing of the stigmas was *three seconds*. It took this six minutes to open again. The longest time for closing of stigmas was twelve seconds, and this occurred on a cool, cloudy day. He says, "It always took twice as many minutes to open as it did seconds to close. After about five trials made in succession, the stigmas refused to act, as if they were tired out."

Mrs. F. A. Gulley, during two weeks of very hot, dry weather, watched a patch of white clover, every day at different times, and never saw an insect near it. At the end of that time, she examined fifty of the heads, twenty-eight of which had no seeds. In the other twenty-two heads there were two or three, and sometimes five or six of the flowers which contained seeds. Previous to dry weather, bumble-bees were abundant on the flowers and these seeded freely.

Mr. E. A. Burke studied the flowers of Indian corn. In nearly all cases, the pollen begins to fall two or three days before the stigmas appear. The first pollen is discharged from the central spike of the tassel and last at the base of the lower or side spikes. The plant sheds pollen continuously for five to eight days. Small bugs seem to be after the pollen.

Mr. A. C. Redding also studied Indian corn. In forty-eight cases out of fifty, the staminate flowers appeared from two to three days before the pistillate flowers. The anthers shed pollen within twenty-four hours after they appeared. The pistils are ready to be fertilized in a few hours after they appear. To prove this, he tied cloths over the whole ear after the pistils had been out for a few hours. In each case the ovules developed. He also tied up some before the stigmas appeared and fertilized them artificially. The kernels all set.

Bees, wasps and other bugs visit the stamens. If the stigmas are soon ready for fertilization after they appear, they are in nearly all cases crossed by pollen from other stalks.

Mr. A. G. Jack observed the flowers of *Epilobium coloratum*. It is well known that *E. angustifolium* is proterandrous or at least most of the stamens are ripe before the stigmas appear. The former plant under consideration has four petals which are two-lobed. It has eight stamens, four of which are long and four short. The four long stamens grow up close to the stigma and

In several cases, flowers were tied up with sarles which kept insects away. No seeds set.

Insects fertilize *Nepeta nuda* in the same manner as they do the catmint.

Mr. Geo. Young found that the flowers of *Nepeta mussini* were also proterandrous and that they were fertilized essentially in the same way as the two species above mentioned. He sprinkled some chalk dust on the back of a bee and soon found that it had come back for more honey. *Salvia Japonica*, *Teucrium Canadense*, thyme, and motherwort were fertilized in the same manner.

A number of spikes of *Teucrium* before flowering were tied up in bags. None of these set seeds. Other spikes were tied up in a similar way. The latter were several times violently shaken without taking off the covers. This caused about one-fifth of the flowers to set seeds.

The fertilization of *Plantago lanceolata* and *P. major* have before been described. The flowers are in spikes. The pistils appear some time before the stamens which are long and reach some distance up the spike. The pollen is dry and the plant is usually described as dependent on the wind for aid in transferring from one flower to another.

Several students have seen honey bees and other wild bees, bugs and flies in considerable numbers about the flowers of *Plantago lanceolata*. These insects, except the bugs, seem to be after the pollen.

Mr. Avery covered buds of *Asclepias cornuti* and they set no fruit. Not all insects about this plant aid in the fertilization. He saw some insects held fast by pollen which they were not stout enough to pull out. Some left their legs and had escaped. Ants get fast sometimes. They were seen to liberate their feet with their jaws.

Mr. L. Wilcox found the flowers of the common teasel proterandrous and dependent on various insects for fertilization.

Mr. H. I. Penoyer finds that the flowers of *Mimulus ringens* are not self-fertilizing but depend on the aid of insects. Detailed experiments were made to prove the statement.

Mr. J. E. Coulter removed the young stamens from flowers of *Scrophularia nodosa* and found that the pistils were fertilized in some way by receiving pollen from other flowers. He also tied up some flowers with paper bags and found that they did not set fruit. Mr. J. R. Shelton removed the stamens from five opening buds, and tied over them a paper bag. After a few days they began to enlarge and develop seeds. He covered five buds not artificially fertilized and they set no fruit. This plant is proterandrous and well described and illustrated in Dr. Gray's neat little book, "How Plants Behave."

Mr. W. E. Hale found that the flower buds of *Campanula rotundifolia* all blasted if tied in paper sacks. It has often been

shown that the stamens shed their pollen on the outside of the style before the stigmas are open.

Mr. W. H. Goss tied paper sacks about flowers of *Lobelia spicata*; none of them bore seeds. From others he cut away the young anthers while very small. The latter were left exposed and all fruited.

Mr. C. A. Ward, on the flowers of *Martynia proboscidia* has seen bumble bees, honey bees and another wild bee. Bumble bees were seen to enter the flowers. The stigmas closed before the bees backed out. The quickest time observed for the closing of the stigmas was *three seconds.* It took this six minutes to open again. The longest time for closing of stigmas was twelve seconds, and this occurred on a cool, cloudy day. He says, "It always took twice as many minutes to open as it did seconds to close. After about five trials made in succession, the stigmas refused to act, as if they were tired out."

Mrs. F. A. Gulley, during two weeks of very hot, dry weather, watched a patch of white clover, every day at different times, and never saw an insect near it. At the end of that time, she examined fifty of the heads, twenty-eight of which had no seeds. In the other twenty-two heads there were two or three, and sometimes five or six of the flowers which contained seeds. Previous to dry weather, bumble-bees were abundant on the flowers and these seeded freely.

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adhere to it, where they discharge their pollen before withering. The four short stamens grow only about half way to the stigma. At no stage of their growth could he find them any longer. Both sets of stamens discharge their pollen at the same time. The short stamens are attached to the base of the petals and when the flowers close, the petals coming together draw the anthers of the short stamens up to the base of the stigmas. Occasionally a small green bee came to the flowers, but they all left at once, as though they had made a mistake. He tied up buds before they were open, and found that the flowers all set seeds freely.

Mr. C. H. Osband finds that the sensitive stigmas of the flowers of trumpet-creepers close in about three seconds after being touched and open in five minutes. Both insects and humming birds aid in fertilization.

THE FUNCTION OF CHLOROPHYLL.—One of the most important recent contributions to physiological botany, is contained in a recent communication to the Berlin Academy of Sciences, by Dr. Pringsheim, which appears to throw considerable fresh light on the function of chlorophyll in the life of the plant.

Having been led by previous researches to the conclusion that important results might be obtained by the use of intense light, he combined an apparatus by which the object under view should be brightly and constantly illuminated by a strong lens and a heliostat. If in this way an object containing chlorophyll—a moss-leaf, fern-prothalium, chara, conferva, or thin section of a leaf of a phanerogam—be observed, it is seen that great charges are produced in a period varying from three to six or more minutes.

The first and most striking result is the complete decomposition of the chlorophyll, so that in a few minutes the object appears as if it had been lying for some days in strong alcohol. Although however, the green color has disappeared, the corpuscles retain their structure essentially unaltered. The change then gradually extends to the other constituents of the cell; the circulation of the protoplasm is arrested; the threads of protoplasm are ruptured and the nucleus displaced; the primordial utricle contracts and becomes permeable to coloring matters; the turgidity of the cell ceases; and the cell presents, in short, all the phenomena of death.

That these effects are not due to the action of the high temperature to which the cell is exposed under these circumstances is shown by the fact that they are produced by all the different parts of the visible spectrum. The result is the same whether the light has previously passed through a red solution of iodine in carbon bisulphide, through a blue ammoniacal solution of cupric oxide, or through a green solution of cupric chloride. If the carbon disulphide solution of iodine be so concentrated that only rays of a greater wave-length than 0.00061 mm. can pass through it, these effects are not produced, although about eighty per cent. of the heat of white sunlight is transmitted. On the other hand, if the

ammoniacal solution of cupric oxide be so concentrated that the whole of the rays of a less wave-length than 0.00051 mm. are absorbed, a rapid and powerful effect is produced, although the amount of heat that passes is very small. It is thus seen that the phenomena in question are not the result of heat.

The next point determined by Dr. Pringsheim, is, that the effects are not produced in an atmosphere devoid of oxygen. This was the case whether the oxygen was replaced by pure hydrogen or by a mixture of hydrogen and carbon dioxide; while the removal of the carbon dioxide from atmospheric air was altogether without effect on the phenomena. The conclusion drawn is that the decomposition of chlorophyll in the living plants is a process of combustion which is influenced and promoted by the action of light, and which is not related to the decomposition of carbon dioxide by the plant. When the green color of the chlorophyll-grains has been partially destroyed, it cannot be restored, even though the cell continues to live; from which it is inferred that the result is not a normal physiological, but a pathological effect. No substance was found in the cells which might be regarded as the product of the decomposition of the chlorophyll, nor was any oil or starch detected in the etiolated cell, nor any formation of grape-sugar or dextrine. The assumption is therefore that the products of decomposition are given off in the gaseous form.

The conclusion is drawn that the decomposition produced in the protoplasm, and in the other colorless cell contents, is the direct effect of the photochemical action of light. That it is not due to the injurious influence of the products of decomposition of the coloring matter of the chlorophyll, is shown by the fact that it takes place equally in cells destitute of chlorophyll, such as the hairs on the filaments of *Tradescantia*, the stinging hairs of the nettle, &c. It is, on the other hand, dependent on the presence of oxygen, or is a phenomenon of combustion.

The results of a variety of experiments leads Dr. Pringsheim to the important and interesting conclusion that the chlorophyll acts as a protective substance to the protoplasm against the injurious influence of light, diminishing the amount of combustion, or, in other words, acting as a regulator of respiration.

He then proceeds to investigate what are the substances which become oxidized in the process of respiration. In every cell, without exception, that contains chlorophyll, Pringsheim finds a substance that can be extracted by immersion in dilute hydrochloric acid for from twelve to twenty-four hours, to which he gives the name *hypochlorin* or *hypochromyl*, and which he believes to be the primary product of the assimilation of the chlorophyll. It occurs in the form of minute viscid drops or masses of a semifluid consistency, which gradually change into long red-brown imperfectly crystalline needles. It is soluble in alcohol, ether,

turpentine and benzol, but insoluble in water and in a solution of sodium chloride. It becomes gradually oxidized on exposure to an imperfectly crystalline resinous substance. It is probably an ethereal oil, and an invariable accompaniment of the coloring substance of chlorophyll, and even more universally distributed than starch or oil. It has not yet been detected in those plants which do not contain true green chlorophyll, such as the Phycochromaceæ, Diatomaceæ, Fucaceæ and Florideæ. Starch and oil appear to be reserve substances produced by the oxidation of the hypochlorin caused by light, it being the most readily oxidizable constituent of the cell, more so even than chlorophyll itself.

That the hypochlorin—present in variable quantity in every chlorophyll grain under normal circumstances—is subject to continual increase and decrease, may be proved without difficulty. All comparative observations on chlorophyll grains in younger and in older conditions, point unmistakably to the conclusion that the collection and increase of the starch enclosed in the ground substance of the chlorophyll, goes on *pari passu* with a decrease of the hypochlorin. In dark, the hypochlorin, which does not take any direct part in the transport of food materials, is more permanent than starch; and this fact again is in agreement with the conclusion that its transformation in the cell into more highly oxidized bodies is hindered by the increased respiration in light.

In the facts here detailed, and the conclusions derived from them, Dr. Pringsheim believes that an entirely new light is thrown on the cause of the well-known fact that assimilation takes place only in those cells of the plant which contain chlorophyll. This substance acts universally as a moderator of respiration by its absorptive influence on light, and hence allows the opposite phenomena of respiration and elimination of carbon dioxide to go on in those cells which contain it. A more detailed account of the experiments and results is promised by the author in a future paper.—*Alfred W. Bennett.*

ZOÖLOGY.[1]

BUNDLES OF SNAKES.—The statements made by Humboldt as to the piles of snakes he saw in Guiana, can be verified here in our northern woods and swamps. I personally had the pleasure of observing it twice, both times very early in spring, and in locations which could be called wildernesses. I first saw such a bundle of snakes in the neighborhood of Ilchester, Howard Co., Md., on the stony bank of the Patapsco river, heaped together on a rock and between big stones. It was a very warm and sunny location, where a human being would scarcely disturb them. I reasoned that the warmth and silence of that secluded place

[1] The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

brought them together. Some hundreds of them could be counted, and all of them I found in a lively state of humor, hissing at me with threatening glances, with combined forces and with such a persistency that stones thrown upon them could not stop them nor alter the position of a single animal. They would make the proper movements and the stone would roll off. All the snakes in this lump were common snakes (*Eutænia sirtalis* L.). The second time I noticed a ball of black snakes (*Bascanion constrictor* L.) rolling slowly down a steep and stony hillside on the bank of the same river, but about two miles above Union Factory, Baltimore county, Md. Some of the snakes were of considerable length and thickness, and, as I noticed clearly, kept together by procreative impulses.

It is surely not agreeable to go near enough to such a wandering, living and hissing hundred-headed ball to examine the doings and actions, and search for the inner causes of such a snake association. As, furthermore, the localities for such mass-meetings of snakes are becoming rarer every year, and our rapidly increasing cultivation of the country must make it hotter for snakes everywhere, only a few naturalists could see such a sight, even if they should look for it in proper time, which, as stated above, seems to be the first warm days in spring.—*E. L., Ellicott Mills, Md.*

Reversed Melanthones.—It is a not uncommon circumstance for collectors, in taking any considerable number of the various so-called species of Melantho, to find a few of them heterostrophal, or sinistral. Dr. Kirtland, in the Ohio Report (quoted by Binney in Land and Fresh-water Shells of North America, p. 44), described one of these abnormal forms as *Paludina heterostropha*, though he evidently was not altogether clear as to its specific value, for he remarks, " I formerly considered it as a mere variety of *P. decisa* Say." This same shell Mr. Binney has referred to *Melantho ponderosus* Say. That all of these sinistral shells *are* abnormal forms of one or more of the well-known Melanthones is now conceded by most naturalists. It was with not a little surprise, therefore, that the writer recently received from a collector in Illinois a reversed shell of *M. subsolidus* Anth. labeled with the old and almost forgotten name given by Dr. Kirtland. Having collected a very large number of the three species common in New York, viz., *M. rufus* Hald., *M. integer* De Kay, and *M. decisus* Say. I wish to place on record the following observations made in the spring of 1877, with reference to the relative abundance of these reversed forms.

The method pursued was as follows: From impregnated shells, about the time of parturition, the young Melanthones were taken and separated into lots of one hundred specimens each. Every shell was then carefully inspected, and it was found in the case of *M. integer* that two per cent. of every one hundred shells were

sinistral. Of *M. rufus*, about one and one-half per cent. of every *one thousand* were thus reversed, while the per cent. of *M. decisus* was between two and two and one-half in each hundred. Comparing these averages with the number of mature reversed specimens collected through quite a long period of time, it was found that only about one-tenth of *one* per cent. survived the accidents consequent on station and environments.

How to account for the presence of sinistral shells at all now became the problem. I submit the following suggestions: Many adult and impregnated specimens were dissected and carefully studied, with the result that the position of the embryonic shells was such as to necessarily crowd them one on another. As they increased in size (this is based upon the inspection of shells in different stages of development), their proximity influenced their assumption of form, more and more, and many curious and abnormal shapes were given the growing shells. Binney (l. c., p. 49) figures some of these forms, while others have been described as species (e. g. *Paludina* (*Melantho*) *genicula* Con.). Mr. Binney very properly groups these aberrant forms under *M. decisus* or *M. integer*. These "shouldered" and otherwise deformed shells are due to the crowding mentioned above. Is it not possible that the reversed forms originate in a similar way; the embryonic shell increasing in the direction of the least, or no resistance? The direction of the "whirl" thus started, would be followed in all the succeeding stages of development.

Mr. Binney doubts the specific identity of *M. rufus* Hald., but if the usually accepted definition of "species" be allowed, without good reason. The three above-mentioned forms are associated in the Erie Canal, at Mohawk, N. Y., and so far as species go they are all valid. The latest understanding of a species would, however, relegate them all, together with the other southern and western forms of the genus, to varieties of one sole type.—*R. Ellsworth Call, School of Science, Dexter, Iowa.*

Laws of Histological Differentiation.—In a recently published article (Proc. Boston Soc. Nat. Hist., Vol. xx, p. 202) Dr. C. S. Minot discusses certain laws of histological differentiation. He maintains that, first, the most primitive form of tissue is an epithelium composed of a single row of polyhedral cells of equal height. Second, very early in the course of development the ectodermic cells become smaller and multiply faster than the cells of the entoderm. Third, the two horizontal axes of an epithelial cell (or those parallel to the surface of the epithelium) usually remain approximately equal to one another in length, while the perpendicular axis varies independently and to a much greater extent. Fourth, epitheliums increase their surface by the formation of depressions (invaginations) or of projecting folds (evaginations). Fifth, structural modifications of epitheliums usually affect similarly a whole cluster or tract of cells, but rarely isolated

cells only. Sixth, probably the primitive cells of the mesoderm are amœboid in character. For all mesodermic cells, not mechanically united with other cells, but capable of independent locomotion by amœboid movements, is proposed the collective name of "*mesamœboids*." The author concludes by saying that if these views are confirmed "we shall then have discovered primary *histological* differences between the three germinal layers in their earliest stages as follows:

EPITHELIAL.

A. Small cells, mainly protoplasmatic........................Ectoderm.
B. Large cells, with much deutoplasm.......................Entoderm.

AMŒBOID.

C. Cells free in the cavity between the two primitive layers, ecto- and entoderm ....Mesoderm.

ANT BATTLES.—I have within the past few years witnessed several battles between ants, and in some instances, the curious conduct of the captors towards their prisoners which I think is worth mentioning. The most noted battle took place July, 1878, between two colonies of red ants. The victorious army were medium in size and numbered many thousands; those captured were a much larger ant, but not so numerous. The large ants after a desperate resistance were forced out of their fort, four or five small ants holding on to the antennæ and legs of the prisoner. The captives were usually taken a few inches away from the fort and liberated. All the ants returned to the fight except one who would stand facing his captive for a few moments, then taking hold of the antennæ of the prisoner give three or four pulls; after waiting a short time the pulling was repeated with more determination; the big ant not responding, he was savagely jerked, then he would lean forward, and a drop of sweet issuing from his mouth, the little ant would approach and drink the nectar, then pick up his captive and hurry home. This was repeated many times during the battle. Some of the prisoners gave up their sweets without so much pulling. I think this battle was for no other purpose than to secure the sweets supposed to be in the stomachs of the captives. These ants were kept prisoners just one week, when they were liberated, marched off in a body and never returned. They were probably kept confined until their sweets were exhausted and then allowed to go free.—*A. Miller, North Manchester, Indiana.*

NOTES ON THE GEOGRAPHICAL DISTRIBUTION OF THE CRUSTACEA.—Mr. Miers in his excellent work on the Crustacea of New Zealand,[1] enumerated several species which were common to that country and America; these are *Neptunus sayi*, *Platyonichus bipustulatus*, *Grapsus pictus*, *G. variegatus*, *Heterograpsus crenulatus*, *Nautilograpsus minutus*, *Plagusia chabrus*, *Leiolophus planis-*

[1] Catalogue of the Stalk and Sessile-eyed Crustacea of New Zealand. Colonial Museum and Geological Survey Department, 1876.

simus, Rhynchocinetes typus, Palæmon tenuicornis Say *(natator* Auct.*), Squilla nepa, Sphæroma gigas.* Mr. T. W. Kirk (Trans. New Zealand Institute, IX, 474, pl. XXVII), adds *Platyonichus ocellatus* and *Squilla armata* to the list, and in a paper now before me[1] *Caprella lobata* and *Petrolisthes rupicolus* are added to the list, the latter illustrated by a figure. In a second paper[2] he reports from his Antipodal Island species before known from British seas, viz.: *Calocaris macandreæ, Portunus pusillus* and *Eleustes panoplus*, but regarding his *Podocerus cylindricus* there may be a doubt, as our author apparently has not access to Say's description, and Spence Bate in his catalogue of Amphipodous Crustacea, describes and figures a distinct species from that of Say, as was pointed out by Smith. Say's type is no longer in existence.

Mr. Wood Mason (the exact reference I have not at hand) reports *Carcinus mænas* from India, and Spence Bate in J. K. Lord's "Naturalist in Vancouver" reports the well known *Gelasimus annulipes* of the east coast of the eastern continent from Vancouver. *G. macrodactylus* Edwards et Lucus, from Chili, is the same species.

I have nearly completed a revision of the genus *Gelasimus*, and perhaps it may not come amiss to state some of my facts in advance of the appearance of the completed paper. *G. maracoani* Latr. (*armatus* Smith), *heterocheles* Bosc. (*patlydactylus* Edw., *princeps* Smith), *vocator* Martens ex Herbst. (*vocans* Edw. *palustris* Edw. *pugnax, mordax et rapax* Smith, *brevifrons* Stm., *affinis* Streets), are found on both shores of our continent, and specimens of *vocator* and *pugillator* are in the museum of the Philadelphia Academy from Mauritius, and of *maracoani* from Natal. *G. coarctatus* was described from Odessa, by the elder Milne-Edwards, while his son reports it from New Caledonia. The Philadelphia Academy possess one of the original specimens which formerly belonged to Guerin-Meneville. No subsequent author (to my knowledge) has ever seen a specimen from Europe. Marcussen in his first paper on the Crustacea of the Black Sea[3] does not mention it, but I have not access to his subsequent paper nor that of Uljanin on the fauna of that locality. Heller in his Crustacea of Southern Europe, quotes it on the authority of Edwards. Now Guerin's specimens and Edwards' description and figure[4] agree well with specimens from the Philippines and Australia, and answer in every particular to the description by Adams and White[5] of *G. forcipatus* from Borneo. The name *coarctatus* must hence lapse into synonymy. I am inclined to consider the locality Odessa as erroneous. From these few facts, selected from

[1] Additions to the Carcinological Fauna of New Zealand. Trans. New Zealand Inst., 1879, pp. 392–397.

[2] l. c., pp. 401–402.

[3] Archiv für Naturgeschichte, XXXIII, pp. 358–363.

[4] Annales Sciences Naturelles, III, XVIII, 146, pl. III, Fig. 6.

[5] Voyage of the Samarang Crustacea, p. 50.

a large number in the writer's notes, it will be seen that our notions of the geographical distribution of marine forms must be considerably modified and that the number of known species is considerably less than the number of descriptions of supposed distinct forms would indicate. I find the fiddler crabs enumerated under nearly one hundred distinct names, while the number of species will not much exceed forty, and this confusion has proceeded partly from the idea that distinct localities must have distinct forms and partly from assuming that minute variable characters were of specific importance; and I would here say that my own work in both of these respects has not been altogether faultless, but I hope ere long to correct my sins of omission and commission.—*J. S. Kingsley.*

THE PSOROSPERMS FOUND IN APHREDODERUS SAYANUS.—Mr. W. P. Seal recently brought me a specimen of this curious little fish, which he had obtained near Woodbury, N. J. The specimen had interested him on account of the great number of large white cysts imbedded in its muscles just beneath the skin, causing the latter to swell outwards, producing an appearance of lumps on the body, as if diseased. When the little animal was held between the eye and light, the embedded cysts being opaque, made it easy to locate each one, and I have sketched this appearance in the accompanying outline (Fig. 1, A) of the fish with the cysts in place. There were about twenty of these cysts in all, which were found to be arranged as a rule in pairs on the opposite sides of the body of the fish.

On cutting through the skin, the cysts were found to have a very thin membrane, which when ruptured, allowed a thick white creamy mass to escape. Upon examining this material with a power of 900 diameters it was found to be entirely composed of very minute ovoid bodies with a tail, as shown in Fig. 2, D: a pair of nucleated elongate bodies were enclosed and attached to the membranous body-wall of what appeared to be the head end. There were many thousands of these bodies in a single cyst, and were it not that the tail did not exhibit the slightest movement, they might have been regarded as spermatozoa. A very few were seen without a tail as in Fig. 2, C.

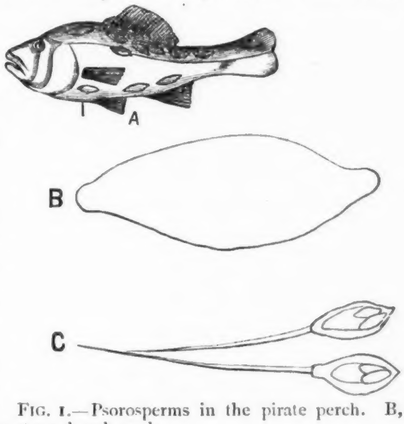

FIG. 1.—Psorosperms in the pirate perch. B, cyst much enlarged.

Fig. 2, B represents an optical section of the head end of one like that shown at D in profile, and shows the oblong attached internal bodies in an excentric position with reference to the enveloping membrane. Excessively minute round granules were found mixed in great abundance with the tailed forms.

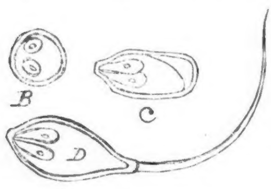

FIG. 2.—Psorosperms.

These are veritable psorosperms and are almost identical in form with those found by Müller in 1841, in European freshwater fishes. The above description is not different in any essential particular, from that given by Müller, and I only offer this account in order that it may induce others to look for similar parasites in other common vertebrates. Cobbold states that they are harmless if eaten with the flesh which contains them, stating that in eating of the heart of a healthy ox, which had furnished part of two meals, he himself must have consumed at least 18,000 of these parasites. They are supposed to be an embryonic stage of development of the Gregarines.

Psorosperms, have not, as far as I am aware, been recorded as being found in *Aphredoderus*, which is a characteristically American fish. There must have been half a million of these embryonic gregarines in the individual fish which I examined.—*John A. Ryder.*

STRUCTURE OF THE EYE OF LIMULUS.—The eyes of the horse-shoe or king crab are four in number; consisting of a pair of compound eyes situated on the side of the head, and a pair of small simple eyes on the front of the head. As described by A. Milne-Edwards and Owen, the optic nerves to these eyes are very long and slender. Those distributed to the larger compound eyes are very long, and close to each eye subdivide into an irregular plexus of fine nerves, a branch being, as we have found, distributed to each facet composing the compound eye. The structure of the eye is very unlike that of any other Arthropod eye. The cornea is simply a smooth convex portion of the integument, which is much thinner than the adjoining part of the chitinous skin. There are no facets, the cornea externally being structureless, simply laminated like the rest of the integument. In the internal side of the cornea are a series of solid chitinous conical bodies, separated from one another by a slight interspace and in form resembling so many minnie-rifle balls; the conical ends of these solid cones project free into the interior of the body, and are enveloped in a dense layer of black pigment. Within the base of these cones are secondary shallow cup-like bodies or shallow secondary cones. It is these primary cones which, seen through the smooth convex translucent cornea, give the appearance of a facetted surface to the external eye.

All the parts thus far described except the pigment layer, are moulted with the rest of the crust, and the latge long slender cones can be easily seen by viewing a piece of the cast-off eye; the solid cones being seen projecting from the inner surface of the cast-off cornea.

The internal structure of the eye is very simple. *There are no cones and no rods*, but a branch of the optic nerve impinges directly upon the end of the solid chitinous cone, as determined by removing the layer of pigment with dilute potash, and treating the section with acetic acid and then staining with picro-carmine. So far as we can ascertain, no Arthropod eye is so simple as that of Limulus. Our observations have been based on a study of the structure of the lobster's eye from preparations of very great beauty and delicacy, kindly made for us by Norman N. Mason, Esq., of Providence, who has also made beautiful sections of the Limulus eye, after treating them in various ways. The question as to the nature of the solid cones we are not yet prepared to settle. Are they crystalline lens or only analogous organs? Can the horse-shoe crab distinguish objects? We doubt if its eyes enable it to more than distinguish between the light and darkness. Since the above remarks were put in type, we have seen Grenacher's great work on the eyes of Arthropoda. He regards the conical chitinous minnie-ball-like bodies as corneal lenses. He does not describe the simple eye, which is a close repetition of one of the corneal lenses of the compound eye of the same animal, except that the lens is shorter and with the end much more obtuse.—*A. S. Packard, Jr.*

Advent of Passer domesticus in North Carolina.—The following letter is published in the belief that it is desirable to preserve records of the spread of this bird in this country.—*Elliott Coues, Washington, D. C.*

Dallas, N. C., Nov. 30, 1879.

Dr. Elliott Coues.

Dear Sir:—Thinking that any information concerning the English sparrow would be appreciated, I take this liberty. On the 23d inst., I saw what I believed to be one of that species at this place, and on the 24th and 25th, I killed two. Both were males. Gaston county, of which Dallas is the county seat, borders on South Carolina, is in the Piedmont region, but still a good ways south, and I had supposed that we would never be invaded. The West and North I had supposed were the only parts of the country that would be cursed with them, but this looks as if they were coming South. They will find no nesting boxes here, however. Are they migratory?

Yours, &c., Paul B. Barringer, M. D.

The Structure of the Tracheæ and the "Peritracheal Circulation" in Insects.—Under this title M. Jules Macleod, of

Gand, has published a prize memoir of more than ordinary value. His conclusions are as follows: 1. The wall of the trachea comprises three layers: one external, probably connective; a middle chitin-forming, and an internal chitinous layer. 2. The spiral thread does not belong properly to the tubular tracheæ. 3. The spiral thread does not differ from the rest of the intima by its thickness alone; but especially in its functions. 4. The tubular tracheæ, and especially the intima of those organs, present numerous variations, even in a given group, like that of the winged insects, for example. 5. The chitin-forming tunic of the trachea is not formed by cells fused together, but it is on the contrary a true epithelium. 6. The middle tunic remains independent along the whole length of the trachea. 7. The peritracheal circulation is anatomically impossible. 8. In many larvæ, the intima presents besides the spiral thread, other parts, differing by their properties.

It will be remembered that Blanchard, and afterwards Agassiz, assumed that there was a circulation of blood between the trachea proper and its investing peritracheal membrane. Joly, and afterwards H. J. Clark of this country, maintained that this was anatomically impossible, and Macleod by experiments and dissections shows that such must be the case.

Vitality of Helix aspera.—Almost incredible statements are found in the books concerning the vitality of snails. I must add another. August 24th, 1878, I ascended an old castle, or square tower, near Queenstown, Ireland, and found between the stones a number of the common garden snail of Europe, *Helix aspera*. I secured three specimens, and having wrapped them in paper, put them in my trunk. On my arrival home, October 28, on looking for my treasures, I found one was crushed. The other two I dipped in water a few seconds, then put them in the fernery, and was delighted to see them crawl about. I could not get them to feed. One died in the following May, having been in confinement nine months. The other died in November, 1879, having lived thirteen months without food.—*S. Lockwood, Freehold, N. J.*

Zoölogical News.—In *Forest and Stream* for Jan. 29, Henry Youle Hind states that the salmon on the Labrador and Newfoundland coast spawn in the spring as well as in the autumn, *i. e.*, that some spawn in the autumn and some in the spring.——A blind Asellus-like Isopod Crustacean has been discovered by Prof. Forel, at great depths, in Lake Leman; the eyes are rudimentary, while the general color of the animal is white.——Mr. Darwin notices, in *Nature*, the fertility of hybrids from the common and Chinese goose, and shows that the fertility is complete. ——M. H. W. Bates states that certain species of Longicorn beetles mimic Lampyrid beetles "with great exactness, the light-

giving segments of the latter being perfectly represented in the Longicorns, although destitute of phosphorescent power."——The Report of the Commissioners of Fisheries of California for 1878 and '79, contains numerous and valuable notes on the food fishes of San Francisco by W. N. Lockington.——The Journal of the Royal Microscopical Society reports the discovery of an Otocyst-like organ in the antennæ of flies (Syrphus, etc.). There seems little doubt but that many Diptera (Muscidæ and Tabanidæ excepted) have these minute ears situated in the third joint of their antennæ. Mayer, however, questions whether these organs, of which he claims to have found fifty in the antennæ of *Musca vomitoria*, are ears, though he regards them as organs of some sense. Dr. H. Krauss finds an otocyst in the larva and imago of Tabanus, the horse-fly.——Dr. H. Burmeister discovers that the fine longitudinal lines or striæ of butterfly scales belong to the upper membrane of the scale, and that they are due to filaments which are elevated on the inner side of the upper membrane. These views are in opposition to those of Beck, and may be incorrect.—— Mr. James Ward has recently been performing some interesting experiments on the nervous system of the cray-fish.[1] He arrives at the conclusions from cutting the nervous cords at various positions, that there is no decussation of the longitudinal nerve fibres unless within the supra-œsophageal ganglion; that the supra-œsophageal ganglion is the highest center of nervous activity, though not identical with the cerebral lobes of vertebrates, and that the infra-œsophageal ganglion is the great center for the co-ordination of the movements of the body. ——The "Arbeiten" of the Zoölogical Institute of Vienna, Vol. II, Part II, 1879, contains a revision of the known genera and species of the Platyscellidæ (Crustacea Amphipoda), and a description of a new Siphonophore from the Mediterranean by Carl Claus. ——Mr. Gibbes[2] has been making some investigations regarding the structure of the spermatozoa, and finds that the head, from its reaction with coloring agents, possesses a different chemical structure from the rest of the organism. A filament was found to arise at the base of the head, in all the animals examined, which was united to the "tail" of the spermatozoön by a delicate membrane, and Mr. Gibbes maintains that the head is enclosed in a sheath continuous with this membrane, and that the motive power lies in the filament and the membrane attaching it to the tail.

[1] Some notes on the Physiology of the Nervous System of the Crayfish. Journal of Physiology, Vol. II, pp. 214–227.

[2] On the Structure of the Vertebrate Spermatozoön, by Heneage Gibbes. Quar. Jour. Micro. Sci., Oct., 1879, pp. 487–491, pl. XXIV.

ANTHROPOLOGY.[1]

Ober's Carribees.—Lee & Shepard, of Boston, have just issued a work entitled "Camps in the Carribees," by Mr. Frederick A. Ober, who undertook a scientific exploration of the Lesser Antilles in 1876. The most of the volume is occupied with a racy account of the naturalist's experience in those islands while collecting specimens in zoölogy. Chapters VI, VII and XIII, however, come under our immediate topic. In two of the smaller islands, Dominica and Saint Vincent, are the only remnants of that powerful race which struck terror into the hearts of Columbus and his followers. Humboldt relates that the Caribs of South America called themselves Carina, Calina, Callinago, Caribi, and that the name Carib is derived from Calina and Califoona; the latter word being the ancient name of their people given to Mr. Ober by the Caribs of St. Vincent and Dominica. This name the author seeks to connect with Shakespere's Caliban, and Robinson Crusoe's "Man Friday." Their ancient savage manners have wonderfully changed, for they are now gentle, hospitable, and kind to their women. They are naturally much lighter than the typical Indian, which has given them the title of "Yellow Indians." In Dominica there are but twenty families of pure Caribs; in Saint Vincent less than six. In the latter island there is an interesting people, called "Black Caribs," formed by the intermarriage of the natives with negroes. Mr. Ober confirms the statement of a difference between the language of the men and that of the women. They have, besides, a certain form of speech which they use among themselves in war-councils. The author inclines to the view that the Caribs were the race who made the beautiful stone implements, collars, mammiform stones, masks, &c., found throughout these islands. In the National Museum is a collection of implements brought by Mr. Ober from Saint Vincent. The volume before us will prove interesting not only to the ethnologist but to the ornithologist, as the appendix contains a list of all birds collected.

Mound Builders.—The second number of Vol. II, of the *American Antiquarian* contains the following papers: The Mound Builders; Explorations by the Muscatine Academy of Sciences, by J. E. Stevenson; Alaska and its Inhabitants, by Rev. Shelton Jackson; Antiquity of the Tobacco Pipe in Europe. Part II. Switzerland, by E. A. Barber; Fort Wayne (old Fort Miami) and the Route from the Maumee to the Wabash, by R. S. Robertson; How the Rabbit Killed the (Male) Winter, an Omaha Fable, by J. O. Dorsey; The Delaware Indians in Ohio, by S. D. Peet; The Silent Races, by L. J. Dupré; Sacrificial Mounds in Illinois and Ohio.

The paper of Mr. Stevenson upon the explorations of the Muscatine Academy is a very important contribution to mound-literature. "From an imaginary point near Drury's Landing, a few

[1] Edited by Prof. Otis T. Mason, Columbian College, Washington, D. C.

miles above and east of Muscatine to another like point, and down the river, near Toolesboro and New Boston, distant from the first point twenty miles, the bluffs (once the Mississippi shore line) recede from each other about eight miles, and upon all the highest points are found groups of mounds, numbering from two to one hundred or more, varying in base diameter from fifteen to one hundred and fifty feet, and from two to fifteen feet in height. In all there cannot be far from two thousand five hundred mounds." Mr. Stevenson enters into a calculation of the time required for their erection. Among civilized peoples, only the head of the family is engaged in active industry; but it is quite possible that men, women and children entered with enthusiasm into this national work. The papers of Messrs. Jackson, Barber, Robinson and Dorsey, are all of permanent ethnological value. Mr. Peet will publish also a quarterly, entitled *The Oriental Journal.*

Mr. F. W. Putnam communicated the following note to the Boston Society of Natural History, October 15, 1879, on the occurrence of chambered barrows in America:

"The chambered mounds are situated in the eastern part of Clay Co., Missouri, and form a large group on both sides of the Missouri river. The chambers are, in the three opened by Mr. Curtiss, about eight feet square, and from four and a half to five feet high, each chamber having a passage-way several feet in length and two in width, leading from the southern side, and opening on the edge of the mound formed by covering the chamber and passage-way with earth. The walls of the chambered passages were about two feet thick, vertical, and well made of stones, which were evenly laid, without clay or mortar of any kind. The top of one of the chambers had a covering of large flat rocks, but the others seem to have been closed over with wood. The chambers were filled with clay which had been burnt, and appeared as if it had fallen in from above. The inside walls of the chambers also showed signs of fire. Under the burnt clay, in each chamber, were found the remains of several human skeletons, all of which had been burnt to such an extent as to leave but small fragments of the bones, which were mixed with the ashes and charcoal. Mr. Curtiss thought that in one chamber he found the remains of five skeletons and in another thirteen. With these skeletons there were a few flint implements and minute fragments of vessels of clay.

"A large mound near the chambered mounds was also opened, but in this no chambers were found. Neither had the bodies been burnt. This mound proved remarkably rich in large flint implements and also contained well-made pottery and a peculiar 'gorget' of red stone. The connection of the people who placed the ashes of their dead in the stone chambers with those who buried their dead in the earth mounds is of course yet to be determined."

Anthropological News.—The question is frequently asked, How does anthropology fare in the catastrophe which destroyed the three surveys of Hayden, Wheeler and Powell? It is the purpose of this brief note to answer this question. In the same bill in which provision was made for the establishment of the new survey under Clarence King, an appropriation was granted for continuing the ethnographic work, and this resulted in the organization of what is known as the Bureau of Ethnology, and Major J. W. Powell was put in command of the corps. This Bureau is now engaged with the aid of skilled collaborators in the following work: 1. Preparing a history of Indian affairs, including an atlas of treaty cessions, exhibiting by graphic signs and descriptive text, the manner and time of the yielding up of our territory by the aborigines. 2. Carrying on an exhaustive investigation concerning the languages of the North American Indians, including a series of grammars and dictionaries and a bibliography. At present it is found convenient to group them into the following linguistic stocks: Adaize, Achomawi, Aleut, Algonkin, Alikwa (Yurok), Ara (Karok), Atakapa, Atimoke (Timucua), Billekula, Bribri, Caddo, Cheroki, Chetimacha, Chiapanec, Chimariko, Chimseyan, Chinuk, Coahuiltec, Coiba (Cueva), Dakota (including Catawba), Galibi, Haida, Hailtsuk, Huave (Wabi), Inuit, Iroquois, Kalapuya, Kera Pueblo, Kaiowa, Kusa, Kutené, Maidu, Maklaks (Klamath), Maskoki, Maya (Mixe), Mutsun, Nahuatl, Numa, Nutka (or Bowatchat), Otomi, Pani, Pirinda, Pomo, Rio Grande Pueblo, Sahaptin, Sasti, Sayuskla, Selish, Seri, Takilma (Kalapuya), Tarasco, Telame (including Santa Barbara and San Antonio), Terraba, Thlinkit, Tinné, Tonkawe, Ulua (Maya), Washo, Wayiletpu, Wichita, Wintum, Wishosk, Xicague (Nicaragua), Yakona, Yokuts, Yaki, Yuma, Yutchi, Zapotec, Zuñi. 3. A collection of a complete synonymy of North American Indians as material for an encyclopedia or classical dictionary of every tribe known to have lived on our continent. 4. An investigation into the sign language, by Colonel Garrick Mallery. 5. An account of savage mythology or philosphy, under the special direction of Major Powell. 6. The study of the arts and industries of all our tribes. During the past summer a party consisting of Mr. James Stevenson, Mr. Frank Cushing and Mr. J. Hillers were dispatched to the Pueblos, with instructions to leave no object, sketch, or custom that would be valuabie to the ethnologist. Mr. Stevenson had charge of the collection, Mr. Hillers of the photography, and Mr. Cushing of the ceremonial part of the work. The first two gentlemen have already returned laden with four car loads of the finest specimens of aboriginal art ever brought together. Mr. Cushing, who has succeeded in ingratiating himself with the Pueblo people, will remain over the winter. The enumeration of a few of the objects in this superb collection will give some idea of its rare value. From Zuñi: pottery, whole and

in fragments, together with clay, and all the implements used in pottery manufacture and decoration, leather dye, dried peaches, bread used in dance, medicine sticks, pottery drums, war shields, carved chairs, snow shovels, bread paddles, dried meat, bows and arrows, toys, moccasins, stone molds, mallets, quoits, rattles, herb tea. From the Moquis:—dresses, looms, sheets, belts, blankets, stockings, dance-ornaments, pouches, sashes, tassels, rabbit-skin robes, saddle bags, boomerangs, stone images, arrows and bows, with all the implements for making them, corn-mills, virgin's head dress, cradles, hair curlers, forceps, lariats, moccasins, dance-ornaments, wrist guards, medicine boxes, balls for play, vermin killers, gambling cups, mush sticks, snares, agricultural implements, water bottles, paint rock, baskets for every purpose. Scattered through the valley of the Rio Grande are nineteen Pueblo villages, and it is designed to make characteristic collections at every one. Mr. Hiller's collection of photographs includes views of the interior and exterior of these Pueblos from every accessible point of view, and of the natives of various ranks in their characteristic attire. The most interesting of his pictures is a group of albinos, the skin and hair being quite white, who intermarry with the other members of the tribe and are very highly esteemed.

Mr. Wm. J. Rhees, chief clerk of the Smithsonian Institution, has edited a pamphlet of 96 pages, entitled "Visitor's Guide to the Smithsonian Institution and National Museum." The latter portion, from page 63 to the end, is occupied with a brief description of Anthropological Hall, under the direction of Dr. Charles Rau. Although the publication is provisional, it is exceedingly timely, and will assist the visitor to acquire a good general knowledge of our national collection.

From London *Nature* we extract the following list of short articles: December 4th, The Turkomans, by H. H. Keane, a review of a paper by Professor Arminius Vambery, before Anthropological Institute of London; Finnic ethnology, a review by A. H. Keane, of "Finnish Crania," by Gustav Retzius, of Stockholm, in December 25th. Dr. Retzius adopts the view that the Finns are amongst the most recent arrivals from Asia; Mr. J. C. Galton reviews at length in January 1 and January 8, Maclay's "Observations upon the Papuans of the Malay coast of New Guinea," giving an account of many most interesting customs; January 5, a review of the following work: Catalogue of specimens illustrating the osteology and dentition of vertebrated animals, recent and extinct, contained in the museum of the Royal College of Surgeons, of England, by William Henry Flower, conservator of the museum. Part I, *Man.* (London: David Bogue, 1879.)

The *Academy* for January 3, announces that Dr. Robert Hartmann is the author of a monograph, entitled "Die Nigritier, eine

anthropologisch-ethnologische Monographie," published as a supplement of five hundred pages to *Zeitschrift für ethnologie*, Berlin.

The October number of the *Revue d'Anthropologie* contains the following original papers and reviews: Notes sur la fécondité des mulatres du Sénégal, by M. Berenger-Feraud, 12 pp.; de la notion de la Race en Anthropologie, by M. Paul Topinard, 72 pp.; Note sur le Développement du Cerveau considéré dans ses Rapports avec le Crâne, by M. Ch. Féré, 14 pp.; Une négresse blanche, by Dr. Smester, 7 pp. La Mythologie Comparée, of M. Girard de Rialle is reviewed in a critique of eight pages, by M. André Lefèvre. The chapter entitled " Revue Préhistorique, by M. E. Callamand, embraces a review of Greenwell's 'British Barrows,' " eleven pages, and a résumé of the prehistoric portion of Bulletin de la Société d'Anthropologie, 4 pp. The book review, by M. Zaborowski, is a critique of 8 pp. on Chudzinski's "Anatomie comparée des circonvolutions cérébrales." Under the Revue des Journaux are reviews upon: Etude sur les crânes boughis et dyaks du Muséum d'histoire naturelle, by Dr. Montano; Anomalie symétrique héréditaire des deux mains, by Dr. Bœchat de Fribourg, in *Bull. Congr. medic. intern.* de Genéve, 1878; Aperçu général de l'hérédité et de ses lois, by Dr. Marc Lorin, Thèse inaugurale de la Faculté de medecine, Paris, 1878; Annales de démographie internationale, recueil trimestriel publié sous la direction du Dr. Arthur Chervin, Deuxieme année, Paris, 1878; Lectures on the Indigenous races of the Pacific Ocean, by William H. Flower; Anthropology of the county of Gloucester, by Dr. John Beddoe, in *Trans. Glouc. Arch. Soc.*, Bristol, 1878; Essay upon the anthropology of Southern Tyrol, based upon the examination of skulls discovered at Saint Pierre, near Meran, by M. Rabl-Ruckhard, *Berlin Gesellsch. f. Anth.*, &c., Feb. 16, 1878. The number closes with brief extracts, a short résumé of the various anthropological congresses during the year, and a bibliographical bulletin of five pages. The most valuable contribution to the number is the paper of M. Topinard upon the idea of "race" in anthropology, and demands more space for a review than we can give it here.

Prof. Friedrich Müller contributes to *Das Ausland*, No. 10, a short article upon the language of animals.

The *Verhandlungen der Berliner Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte* from January-February of the current year, give us a digest of the proceedings of that celebrated society. In turning over the leaves we find quite extended abstracts of the following communications: Session of Jan 11. Skull from the Bone-Cave of Gorenice, near Ojcow, Poland, by Ferd. Römer, in Breslau, with Table IV; Upon the stone implements of Japan, and upon various antiquities in the collection of the German Society for the study of Eastern Asia, by Hr. v. Brandt; Results of his measurements of school children, by Pro-

fessor Lucæ; Upon the language of the Australians, by Hr. Steinthal. Session of Jan. 18: "Face-urn" from a stone-cyst grave in Gabolin (Kreis culm, West Prussia); Fung Schui, or Chinese "Geomanty;" Black pottery in India and in Turkey, by Hr. Jagor; Upon the cemetery of Giebichenstein, near Halle, Hr. Credner. Session of Feb. 15: The canicars of Southern India, by Hr. Jagor.

The following titles from various sources may be of service to some of our readers: The oldest art in the world, by W. J. Loftie, (*Macmillan's Mag.*) *Electic Mag.*, Dec., 4 pp.; Beasts, Birds, and Insects in Irish Folk-Lore, by Letitia McClintock, *Belgravia*, Nov., 8 pp.; The Ancient Remains at Bounarbashi, by W. Simpson, *London Academy*, Nov. 1; Cinderella, by W. R. S. Ralston, *Nineteenth Century*, Nov., 22 pp.; The study of Cuneiform Archæology, by Rev. B. W. Saville, *Clergyman's Magazine*, Nov., 16 pp.; The Deluge: Its traditions in Ancient Nations, by F. Lenormant, *Contemporary Rev.*, Nov.; The Supreme God in the Indo-European Mythology, by J. Darmsteter, *Contemporary Rev.*, *Living Age*, Oct. 25, 10 pp.; The Hittites in Asia Minor, *London Academy*, Nov. 1; Monumental Inscriptions in all parts of the world, *Calcutta Rev.*, July; Pliocene Man, by Dr. C. C. Abbott, *Kansas City Review*, Nov.; Pottery in Prehistoric Times, by L. Jewitt, *Illustr. Art Journ.*, Nov., 3 pp; Preservation of Ancient Ruins and Monuments, *Chamber's Journal*, Nov.; Les Temps oublies, by E. Littré, *Philosophie Positive Revue*, Dec., 8 pp.; Fetish or Rag Bushes in Madagascar, *Saturday Mag.*, Nov. 22; The Music of Hindustan, by B. S. P. Ghosha, *Calcutta Rev.*, July; Institutions et Mœurs Annamites, by T. V. Ky, *Philosophie Positive Revue*, Dec., 12 pp.; Language and the Egyptian Language, by Dr. C. Abel, *New Englander*, Nov., 15 pp.; Des Origines et de l'Evolution du Droit economique, by H. Denis, *Philosophie Positive Revue*, Dec., 12 pp.; The Bohemians and Slovaks, *Westminster Rev.*, Oct., 30 pp.; Cabul and its People, *Saturday Mag.*, Nov. 8, 2 pp.

The following are recent articles of interest:

CHARENCY, M. DE—Ages Cosmiques d'apres la Mythologie mexicaine, I. *Annales de Philosophie Chretienne*, Nov., 15 pp.

BUDGE, A.—Assyrian Incantations to Fire and Water. *Tr. Soc. Biblical Archæology*, VI, 2.

BOSCAWEN, W.—Notes on Assyrian Religion and Mythology. *Tr. Soc. Biblical Archæology*, VI, 2.

HOUGHTON, W.—Hieroglyphic or picture origin of the characters of the Assyrian Syllabary. *Tr. Soc. Biblical Archæology*, VI, 2.

MCCLINTOCK, LETITIA—Beasts, Birds and Insects in Irish Folk-lore. *Eclectic Mag.*, Jan., from *Belgravia*.

COX, REV. G. W.—Homeric Mythology and Religion. A Reply to Mr. Gladstone. *Frazer's Mag.*, Dec.

Forms of Salutations. *Eclectic Mag.*, Jan.

MENON, P. S.—On the Coast of Madagascar. *Madras J. of Literature*, I.

ROGERS, E. T.—Dialects of Arabic. *J. of Roy. Asiatic Soc.*, Aug.

VINSON, J.—Esquisse Grammaticale de la Langue de God. *Rev. Linguistique*, Oct.
ASTON, W. G.—A Comparative study of the Javanese and Corean Languages. *J. of Roy. Asiatic Soc.*, Aug.
 Grammaire Samoane. *Rev. Linguistique*, Oct.
OPPERT, G.—On the Ancient Commerce of India. *Madras J. of Literature*, I.

GEOLOGY AND PALÆONTOLOGY.

FOSSIL CRAWFISH FROM THE TERTIARIES OF WYOMING.—Two specimens of fossil crawfish quite well preserved have been kindly loaned us for description by Professor Leidy, who received them from the fish beds of the western border of Wyoming, through Dr. J. Van A. Carter, of Evanston, Wyoming. Of the two specimens, the smaller presents a dorsal, and the larger a lateral view, both being slightly distorted by pressure; the length of the smaller from the tip of the rostrum to the end of the telson is 38 mm., and of the larger 53 mm. They do not differ generically from existing species of Cambarus, though with some resemblances to Astacus, but as the gills are not represented it is not possible to say to which of these two genera the species belongs; still the weight of characters ally it nearest to *Cambarus affinis*, as seen in the long narrow pointed rostrum, and the form of the chelæ and the second antennal scales. These scales are also much as in *C. obesus* var. *latimanus* and *bartonii*, but rather narrower, the lateral terminal spine being long, slender, acute. The flagellum of the second antennæ are of the usual size, extending to the terminal fourth of the abdomen. The distal end of the scape of the first antennæ reach to near the end of the last joint of the scape of the first pair, the species in this respect being more like Cambarus than Astacus. The carapace is of the proportions of living species of Cambarus. The first pair of legs are rather shorter and stouter than in our living crawfishes, and the chelæ are rather shorter, while the surface of the carapace and legs is much more coarsely tuberculated than in our Cambari, and in this respect resembles large specimens of *Astacus fluviatilis* of Europe, though the tubercles are larger.

The abdomen is of the usual proportions, but the surface is more coarsely tubercled; the telson and broad rami of the last pair of feet are spined as in living species of Cambarus. It is interesting to observe that this species is nearest related to *Cambarus affinis*, which as observed to me by Mr. P. R. Uhler, who kindly gave me some species for comparison, is the more generalized American species of the genus, and probably the oldest one. It would be interesting to know whether this fossil form is actually a Cambarus or an Astacus, and to ascertain which of these two genera, now restricted, the latter to the Pacific slope of the Sierra Nevada, the former to the Central and Eastern zoö-geographical provinces, was the first to obtain a foothold on our continent. There is a probability that the present fossil form is a member

of the American genus Cambarus. The species may be called, therefore, *Cambarus primævus.—A. S. Packard, Jr.*

On the Sauropterygia of Boulogne-sur-Mer.—Dr. H. E. Sauvage has recently published an interesting memoir on the above subject, including in it many general remarks on the affinities and contents of the order *Sauropterygia.* He uses the results of the latest investigations on the subject, referring especially to those of Seeley. He describes several species heretofore very little known, and adds a number of new ones to Scientific Literature. Those which Dr. Sauvage finds in the Upper Jurassic beds of the Boulonnais are: *Pliosaurus gamma* Ow.; *P. grandis* Ow.; *P. suprajurensis* Sauv.; *Polytychodon archiaci* E. E. Desl.; *Plesiosaurus carinatus* Ow.; *P. phillipsi* Sauvg.; *P. morinicus* Sauvg.; *P. infraplanus* Phil.; *P. plicatus* Phil.; *P. ellipsospondylus* Ow.; *Colymbosaurus dutertrei* Sauvg.; *Murænosaurus manseli* Hulke; *Polycotylus suprajurensis* Sauvg.

A new Hippidium.—A species apparently of this genus of horses has been discovered by Prof. Thomas Condon in the Loup Fork beds of Cottonwood creek, Oregon. It is represented as yet by superior molar teeth only, which are larger than those of any of extinct American horses, excepting the *Equus excelsus,* about equaling those of *Hippidium neogæum* Lund. The crowns of these teeth are very long and slightly curved, and the roots are short. The internal columns are relatively small, are subequal in size, and are flattened in outline. A peculiarity of the species is seen in the great transverse width of the lakes which, at the middle, is equal to the anteroposterior diameter. The crescents, and especially the inner ones, are correspondingly narrow. The enamel borders are simple, there being only a few notches on the adjacent faces of the lakes. One loop projects from the inner enamel border, almost reaching the anterior inner column. Cement abundant. Diameters of second premolar: anteroposterior, m. .035; transverse behind .021; height of crown .035. Diameters of a superior molar: anteroposterior, .027; transverse, do., including external ridge, .027; longitudinal externally, .045. The species of the genus heretofore described from the United States (*H. pernix* and *H. robustus*), are represented as having teeth with short crowns and long fangs, and of materially smaller size. The species may be called *H. spectans.* The teeth are about the size of those of the quagga.—*E. D. Cope.*

GEOGRAPHY AND TRAVELS.[1]

United States Geological and Geographical Survey of the Territories. Work of 1877–8, Primary Triangulation and Yellowstone Park Maps.—Among the posthumous works of Dr. F. V. Hayden's Survey of the Territories, there have recently

[1] Edited by Ellis H. Yarnall, Philadelphia.

appeared a series of maps, comprising most of the topographical work of the last two years, 1877 and 1878. This series comprises a sketch of the primary triangulation, and a drainage map, each covering the whole area surveyed, on a scale of eight miles to an inch, a detailed map of the Yellowstone National Park, on a scale of two miles to an inch, and three detailed atlas sheets, on a scale of four miles to an inch, The last three sheets were noticed in the number of the NATURALIST for January.

The triangulation sheet shows the scheme of the primary triangulation, the stations, the sight lines, the closed and open triangles, the details of the expansions from the bases, and the astronomical connections.

The base lines were two in number, one near Fort Steele, on the Union Pacific railroad, Wyoming, the other in the valley of Bear River, near the village of Georgetown, Idaho. Each was between five and six miles in length, about two miles of which appear to have been measured directly, while the balance was ranged out by small, well proportioned triangles. The expansions were by means of closed triangles, and, apparently were well executed. The astronomical connections were ample, consisting of stations at Sherman and Fort Steele in Wyoming, Salt Lake City and Ogden in Utah. These points were located by the Coast Survey and by Lieut. Wheeler of the Engineer Corps. The scheme is well planned, most of the triangles being well proportioned and the only failures are unquestionably due to the incompleteness of the work, owing to the abrupt discontinuance of the survey.

Since the discovery of the wonders of the Yellowstone country, in 1870, this region has been a favorite field of exploration. Expedition after expedition has traversed it, each following much the same routes as its predecessors, and, after the first, adding but little to the sum of human knowledge regarding this strange fire-ridden region.

The explorations in this region, of the survey under Dr. F. V. Hayden, in 1871 and 1872, were singularly prolific of facts, geological, physical and geographical, and little that was new was evolved from numerous expeditions that followed. The big nuggets had been taken, and nothing but a careful, scientific, reworking of the tailings would extract from them the wealth of fine gold which they still held.

In 1878, Dr. Hayden's survey reached this region in the prosecution of its system of surveys. Its work had, years previously, passed from the reconnoissance stage to that of systematic surveys on a scale and of a degree of accuracy commensurate with the needs of the country.

In that year, a party was directed to make a detailed survey of the Yellowstone Park, its geography, geology and volcanic phenomena.

A part of the results of this season's work is now before the

world, in the form of a map of the Yellowstone Park on a scale of two miles to an inch, a scale sufficiently large to show all details necessary to the geologist, or the traveler. The topography is represented by contour lines, at approximate intervals of one hundred feet. This map, as well as the others published by this survey, are admirable illustrations of relief-effect by means of contours; and they not only express the relief, but the absolute and relative elevations.

From a study of this map, we find that the greater part of the surface of the Park consists of high rolling plateaus, broken by stream beds, cliffs and cañons. Several small groups of mountains diversify the surface, among them the Red mountains, in the southern part, rising two thousand feet above the general level, or more than ten thousand feet above the sea—and the Washburn group, near the middle of the Park. This group has the form of a horseshoe, opening towards the east. The eastern border of the Park is occupied by a high, rugged range, to which has long attached the name of Yellowstone Range. Index peak; the highest measured peak in this range, exceeds 11,700 feet in height. In the north-western corner of the Park is the southern extremity of the Gallatin range, culminating in Electric Peak, a magnificent summit, 11,155 feet above the sea, which overlooks almost the whole Park.

The mean elevation of this reservation appears to be not far from 8000 feet, an elevation so great in this latitude as to presuppose an almost arctic climate. The lowest point within its limits is at the mouth of Gardiner's river, on the Yellowstone, which is 5360 feet.

Marked features of the reservation are the low, indefinite divides and the abundance of lakes and marshes. In several cases we note marshes extending across divides and making "two ocean rivers," phenomena by no means as uncommon as are popularly supposed. The lakes, principal among which are Yellowstone, Shoshone, Lewis and Heart, cover nearly 200 square miles out of the total area of the park, which is estimated at 3312 square miles.

Many newly discovered groups of hot springs and geysers appear, for the first time, on this map, among which should be mentioned the large and fine groups near the head of Gibbon's fork of the Firehole, the discovery of which has been previously noticed.

The engraving of these maps, by Bien, of New York, is one of the best specimens of his very excellent work.

MICROSCOPY.[1]

Hints on the Preservation of Living Objects, and their Examination Under the Microscope.—I will now give a short summary of the most useful apparatus for the examination of liv-

[1] This department is edited by Dr. R. H. Ward, Troy, N. Y.

ing objects. The simple glass slip, three inches by 1 inch, or better, a ledged stage-plate three inches by one and a half inches, with narrow strip of glass cemented along one edge. One of these, with cover-glass, is often all the apparatus necessary to use with small infusoria and free-swimming rotifers, and is also occasionally available with a little management for larger objects, either free or attached. Manipulation with these I cannot better describe than in the words of Judge Bedwell in his description of what I call Bedwell's rotifer-trap.

"Take a plane glass slide, on it drop one or more of the rotifers in a drop of water, about half an inch in diameter, and draw off the surplus water if any, carefully with the empty pipette; then fray out a very, very small portion of cotton wool (I always use a watchmaker's glass in the eye to do all such operations) until it is much extended, and spread out and lay this on the drop. Upon that lay the thin microscopic glass, the thinner the better, and then set up the capillary attraction by gently touching it with a needle. Draw off any superfluous water from the edges with the pocket-handkerchief, and you will have a little wilderness of wool in in which the rotifer is restrained in its movements, protected from pressure, and within reach of very high powers. The amount of wool depends on the size of the rotifer. Hydatina requires more depth than Rhinops. The same plan answers equally well for all roving animals. The Goduridæ in particular, when placed in deep glass cells, are easily seen by this apparatus, and it saves many a weary and vexatious five minutes with the compressorium, which even at the best, requires with living animals extraordinary patience. The rotifers are easily found and secured with the pipette and a watchmaker's glass in the eye after a very little practice. Mr. Bolton's studio is of the greatest value to naturalists, and cannot be too well known, for to those who have not time to look for specimens it is a great privilege to be able to purchase them."

Another simple apparatus I call the Wills' compressorium. Most forms of compressorium are useless—all are expensive. Those who try the following will be surprised at the efficiency of the apparatus. Two pieces of thin glass are cemented on to a glass slip in the shape of the letter L, but with the two strokes of the letter about equal in length, and another thinner and longer one is fixed longitudinally, thus L——. The L serves to retain in position a square slip of cover glass placed, of course, not on the L, but inside it; the horizontal piece, which should be ground to a bevel on its top edge before fixing it, serves to carry a fine needle, the point of which is inserted beneath the edge of the cover glass. This point being tapered, it is easy to increase or diminish the thickness of a film of water carried between the cover and the slip by pushing the needle further in or out, and so to form a cheap and effective compressorium.—*T. Bolton in English Mechanic.*

METHOD OF SEPARATING ORGANISMS FROM WATER.—In order to reduce the quantity of water containing infusoria, obtained by means of a collecting bottle or otherwise, an easy and effective method is to allow the liquid to stand in a bowl until it has settled, and then take up the water by means of a sponge placed in a pouch made of fine silk. If the water be allowed to soak into the sponge very gradually and a slight pressure be given before removing it from the bowl so as to wash away any adherent particles, even the finer forms of animalculæ diffused through a pint of water may be left in great abundance in a quantity of water not larger than a tablespoonful.—*M. A. Veeder.*

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SCIENTIFIC NEWS.

— One of the best and most successful fish culturists and practical ichthyologists in America has passed away. James W. Milner was born in Kingston, Ontario, January 11, 1841; he came to Chicago when about five years old, and he grew to manhood there, showing even as a child great, almost excessive devotion to study, the effects of which impaired his physical condition on more than one occasion.

He left the Northwestern University, before graduating, to take a place as a private soldier in the 1st Illinois Light Artillery. During his military service, which lasted until 1864, he exhibited an enthusiastic patriotism, courage and endurance, with a kindly interest in the comfort and welfare of those about him which made him a universal favorite. He passed through many of the severest battles of the war and volunteered at Vicksburg for the rescue of the wounded after the disastrous repulse of the "forlorn hope." Doubtless the privations which he endured somewhat undermined his constitution, and he took to farming, under the persuasion of his father, in hope of recovering in this way some of his lost vigor.

About 1870 his work in the direction of natural history led to a correspondence with Prof. S. F. Baird, and afterwards to his appointment as Deputy U. S. Fish Commissioner, which he retained until his death. Among his associates at the Smithsonian Institution, there was a general appreciation of his abilities as an observer and his qualities as a man. His chief interest and field of work lay in the culture, hatching and transportation of various fishes and invertebrates for economical purposes, which necessitated a very thorough study of their habits and conditions in a state of nature.

Among the works published by him the most noteworthy articles are those relating to the fishes of the great lakes, especially the whitefish, and his study of the graylings. He was naturally modest and given to underrating the value of his own work, and hence was not easily persuaded to publish his studies. On the

history of fish culture and its practical workings he was doubtless better informed than any one else in this country at the time of his death. His enthusiastic and successful attempt at the fertilization and hatching of the eggs of the cod (never before attempted) kept him during an inclement season at Gloucester, Mass., under circumstances of great exposure. The disease of which he died was then first developed, though its seeds had doubtless long been latent in his system. A winter in Florida, a summer in Colorado, both came too late for his recovery to be even hoped for, and returning to his Illinois home (at Waukegan) he passed away in the midst of his family on the 6th of January, 1880. He left a wife and two children. Not only these bereaved ones will feel his loss. Those who knew him realize that a warm friend, a man of truth, integrity, modesty and sterling worth has been taken away, and that the pen of a careful, conscientious and intelligent observer and student has been laid down forever.—*W. H. Dall.*

— The collection of the late Dr. Asa Fitch comprised one hundred and six heavy cork-lined boxes (the cartons liégés of Deyrolle, 26 × 19½ c. m.), nearly all of double depth, and with the exception of a slight deposit of mold, easily removed, and a very small percentage of loose or broken specimens it is in excellent condition. While the bulk of the material is from the United States, and principally of the doctor's own collecting in the vicinity of his residence at Salem, Washington county, N. Y., there are also many species from all parts of the world received from exchanges with his correspondents, Drs. Sichel, Signoret, Fairmaire and Andrew Murray. The Coleoptera occupy eighteen boxes; the Orthoptera, seven; Neuroptera, six; Hymenoptera, eight; Lepidoptera, twenty-one, of which four only contain the diurnal species. Both divisions of the Hemiptera are nobly represented, the Heteropterous by fourteen boxes, and the Homopterous, to which as most naturalists are aware the doctor devoted especial attention, fill twelve boxes, and preserve as do the other orders apparently all the types of the descriptions published in the New York State Agricultural Reports, and other articles. Five boxes exhibit an excellent set of American Diptera with many exotic forms, and four are devoted to Myriapoda, Arachnida and Crustacea.

Some thousands of European and other exotic species received from Sichel, Signoret, A de la Cerda, and the late Rev. M. S. Culbertson, who collected at Hong Kong, appear never to have been incorporated with the main collection, but are generally in good condition, occupying twenty-five or more boxes of various sizes. Several hundred biological illustrations, principally "galls," &c., occupy three or four double boxes, and are now in good order, but very liable to be disarranged in the event of transportation.

Two cases exhibit a vast amount of patient labor on the Ceci-

domyia and allied genera, but have suffered seriously from the inroads of *Ptinus fur*, which we caught in the act of demolition.

An extensive collection of duplicates, including about one hundred thousand Coleoptera, and perhaps twenty-five thousand of all other orders, have been invaded by *Dermestes lardarius* and injured to an extent not exceeding twenty per cent. These are contained in two pine cases, each containing about thirty-six slides or rimless drawers, in which the pins are feebly secured by slits or incisions in the wood. There are no traces of *Anthrenus* or *Tinea*, and little if any of the more minute museum pests in any part of the collection.

One hundred and forty-eight small thick note-books contain in fine MSS., the locality, date of capture, &c., of nearly every specimen; their numbers reaching fifty-five thousand; the record commencing about the year 1833. Each species is accompanied by a brief diagnosis, followed on a subsequent page by a fuller description with notes and observations. The whole forming an almost exhaustive descriptive catalogue of the collection of inestimable value and which should of course never be separated therefrom. Several microscopes, among them a valuable upright Nachet with all accessories, made expressly for the doctor, only a few years ago, and a large and valuable library containing many rare and curious as well as unique works on entomological subjects are also stored in the small wooden building known as the "Office," a few rods in the rear of the hundred-year old homestead or dwelling-house.

An extensive collection of minerals, as well as a few specimens of local birds and mammals and a good alcoholic collection of the Washington county reptiles and fishes also attest the labors of the eminent naturalist.

— It is with sincere regret that we record the death, on January 23d, of Dr. Thomas M. Brewer, the distinguished ornithologist, whose geniality and courtesy won him friends all over the country, and whose labors as a naturalist entitled him to the warm regard of all lovers of nature. Dr. Brewer paid, as is well known, special attention to the study of the habits, nests and eggs of birds; publishing an elaborate and beautifully illustrated treatise on the eggs of birds; he supplied this part to Baird, Brewer and Ridgway's great book on the birds of the United States.

Dr. Brewer was born November 21, 1814, graduated at Harvard in 1835, and began the practice of medicine three years later. He was one of the oldest and most active of the working members of the Boston Society of Natural History; had just completed a catalogue of the large collection of humming birds of the Boston Society, in whose Proceedings most of his papers appeared, and had almost completed the collection of New England birds, which he had been at work upon for several

years. The society owes its large collection of bird's eggs, and many of its choicest native birds to his labors.

— Volume x of the new edition of the Encyclopædia Brittanica just issued from the press, contains a long and elaborate article by Prof. Archibald Geikie on Geology. It is nearly as comprehensive as the ordinary manuals on that subject, and will be still farther expanded into an advanced text book for schools and colleges, and published by Macmillan & Co. The article in the Encyclopœdia contains several sections, namely, the Cosmical Aspects of Geology, Geognosy, an inquiry into the materials of the Earth's substance, Dynamical Geology, Structural Geology, Palæontological Geology, Stratigraphical Geology and Physiographical Geology. Like all the former works of Prof. Geikie, this article exhibits marked originality and great literary merit. There are very few writers on scientific subjects on either side of the Atlantic who possess a more masterly use of the English language.

— We have received the first number of the *American Entomologist,* Vol. I, new series, edited by C. V. Riley and A. S. Fuller, and published by Max Jægerhuber, 323 Pearl street, New York. It worthily continues the first series of this journal which was suspended nine years since. The number is replete with entertaining and popular matter most useful to farmers and horticulturists, and deserving of the widest circulation. Articles on the hibernation of the cotton worm, by C. V. Riley, from advance sheets of Bulletin 3 of the U. S. Entomological Commission; on the food-habits of thrushes, by S. A. Forbes, and others of not less interest, with a number of shorter notes and paragraphs, render the contents varied and interesting.

— The grand Walker prize of the Boston Society of Natural History, founded by the late Dr. William J. Walker, and bestowed every ten years for excellence in original biological work, was, in January last, awarded to Professor Joseph Leidy, of Philadelphia. We need hardly say that the award will meet with the warm approval of every naturalist in the country, as Dr. Leidy, by his contributions to the comparative anatomy of both the Invertebrates and Vertebrates, to Vertebrate palæontology, his studies on the Protozoa, the intestinal worms, and the work he has done in other directions most justly entitle him to this prize, which is a substantial one, amounting to $1000.

— We have been delayed in noticing the second contribution from the E. M. Museum of Geology and Archæology of Princeton College, which embraces a topographic, hypsometric and meteorologic report by William Libby, Jr., and W. W. McDonald, of the Princeton Scientific Expedition to Colorado, Utah and Wyoming, undertaken in 1877. The report is of very considerable value and contains a number of excellent photographs of the mountain scenery.

— Theodore Fischer announces the publication of six of a series of Palæontological wall illustrations, which are one hundred ctm. broad, and one hundred and forty ctm. high, at the price of twelve marks a Lieferung, containing six plates, representing Protozoa, sponges, corals, Brachiopods and an ideal landscape of the coal formation. They are edited by Drs. Zittel and Haushofer. The whole collection will contain from forty-five to fifty diagrams, comprising seven landscapes, five or six plates of fossil plants, the remainder of fossil animals.

— The Boston Society of Natural History proposes, as a part of the celebration of its fiftieth anniversary, to publish a handsome quarto volume containing a series of illustrated articles in different branches of natural science, with a sketch of the society's history. The volume will contain several hundred pages and many plates. The price of the volume has been fixed at $10.

— Mr. Defrees, the public printer, will receive until June first, orders for the new edition of the Narrative of the *Polaris*, at two dollars per copy. The money must be sent him with the order. This is the splendid edition of which extra copies have been sold by authority of Congress at ten per cent. above the cost of press work and paper.

— Mr. P. N. Seminoff, of the Natural History Faculty of the University of St. Petersburg, desires North American Coleoptera in exchange for those of Russia. Any correspondence in regard to exchanges can be made through Hon. N. Shishkin, Washington, Russian Minister to the United States.

— Dr. A. E. Foote's *Leisure Hour* comes to us filled with useful information, especially on the subject of mineralogy. It also presents us with the fullest sale list of the publications of cotemporary American naturalists that exists, so far as we are aware.

— Mr. George A. Bates has established at Salem, Mass., a Naturalists' Bureau for the sale of works on natural history, authors' extras of their scientific papers, and specimens.

— Since the transfer of the NATURALIST to the hands of the present publishers, its subscription list has largely increased. We have increased the number of pages of the magazine with the present year, and have added to the number of illustrations. We hope our readers will bear these facts in mind and represent them to their friends. No popular scientific journal in the world possesses a corps of editors which includes so many names well known in American natural science. Our contributors are derived from the same class of workers, so that we do not exaggerate, we think, in asserting that the NATURALIST is indispensable to persons desiring to keep abreast of the times. We have also undertaken to publish an annual record of progress in science, which will be equally indispensable to the general reader.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

AMERICAN GEOGRAPHICAL SOCIETY, New York, January 13.—A paper was read by B. R. Curtis, Esq., entitled A voyage around the world.

February 10.—Prof. John B. McMaster read a paper entitled the Bad Lands, or Mauvaises Terres, of Wyoming.

NEW YORK ACADEMY OF SCIENCES, January 19.—Dr. H. A. Mott spoke on the diamond, its artificial production and uses.

January 26.—Prof. J. S. Newberry remarked on some peculiar silver deposits in Utah and Colorado, and Mr. S. W Ford spoke on the recent discoveries of fossils in the limestone of the Wappinger valley, N. Y.

BOSTON SOCIETY OF NATURAL HISTORY, January 21.—Mr. Diller replied to Mr. Crosby's remarks on the felsites north of Boston; Mr. Crosby made a communication on distorted pebbles in conglomerates.

February 4.—Dr. J. W. Fewkes described the pinnal sucker of certain Heteropods, and Mr. F. W. Putnam remarked on the former Indians of Southern California and their relation to the origin of the red man of North America. At the meeting of the Section of Microscopy, Mr. M. E. Wadsworth spoke concerning the cutting of rock sections.

APPALACHIAN MOUNTAIN CLUB, January 14.—Prof. W. H. Niles delivered an address as the retiring president of the club.

February 11.—Prof. E. C. Pickering spoke on atmospheric refraction, and Mr. W. H. Pickering addressed the club in reference to future Arctic explorations.

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SELECTED ARTICLES IN SCIENTIFIC SERIALS.

AMERICAN JOURNAL OF SCIENCE AND ARTS.—February. Notice of recent additions to the marine fauna of the eastern coast of North America, by A. E. Verrill. The limbs of Sauranodon, by O. C. Marsh.

THE GEOLOGICAL MAGAZINE.—January. On some fossil bird remains from the Siwalik hills, India, by W. Davies.

ANNALES DES SCIENCES NATURELLES, 1879.—On the Plesiosaurians and Elasmosaurians of the Upper Jurassic, by M. Sauvage.

QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE.—January. On the development of the Spermatozoa. Part I. Lumbricus, by J. E. Bloomfield. On the spinal nerves of Amphioxus, by F. M. Balfour.

CANADIAN ENTOMOLOGIST.—January. Description of the preparatory stages of *Grapta progne*, by W. H. Edwards.

CANADIAN NATURALIST.—December 29, 1879. Preglacial formation of the beds of the Great American lakes, by E. W. Claypole. Note on recent controversies respecting *Eozoön canadense*, by J. W. Dawson.